US009085005B2

(12) **United States Patent**
Townsend

(10) **Patent No.: US 9,085,005 B2**
(45) **Date of Patent: Jul. 21, 2015**

(54) **AUTOMATIC NOZZLE CHANGER**

(75) Inventor: **Michael Townsend**, Waitsburg, WA (US)

(73) Assignee: **NELSON IRRIGATION CORPORATION**, Walla Walla, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1264 days.

(21) Appl. No.: **12/457,121**

(22) Filed: **Jun. 1, 2009**

(65) **Prior Publication Data**

US 2010/0301130 A1 Dec. 2, 2010

(51) **Int. Cl.**

A62C 31/02	(2006.01)
A62C 31/00	(2006.01)
B05B 1/32	(2006.01)
B05B 15/06	(2006.01)
B05B 1/16	(2006.01)
B05B 3/04	(2006.01)
B05B 15/08	(2006.01)

(52) **U.S. Cl.**

CPC ***B05B 1/1681*** (2013.01); ***B05B 1/169*** (2013.01); ***B05B 3/0486*** (2013.01); *B05B 15/08* (2013.01)

(58) **Field of Classification Search**

CPC B05B 1/1681; B05B 1/169; B05B 1/16; B05B 1/1654; B05B 1/1645; B05B 15/08; B05B 15/065; B05B 15/10; B05B 12/002; B05B 3/0486; A01G 25/162

USPC 239/394, 391, 392, 393, 396, 397, 436, 239/437, 438, 504, 505, 518, 523, 201, 208, 239/209, 541, 11, 66, 451–460, 395; 169/37; 401/109, 110, 111, 112

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,979,179	A *	10/1934	Taylor	239/85
2,944,705	A *	7/1960	Strumor	222/94
3,124,162	A *	3/1964	Cameron	137/625.11
3,191,809	A *	6/1965	Schultz et al.	222/182
3,351,250	A *	11/1967	West	222/532
3,385,525	A *	5/1968	Jacobs	239/394
3,459,208	A *	8/1969	Clyde	137/119.03
3,472,265	A *	10/1969	Davis	137/119.03
3,596,835	A *	8/1971	Smith et al.	239/394
3,642,022	A *	2/1972	Kirby	137/119.03
3,779,533	A *	12/1973	Etter	239/394
3,817,300	A *	6/1974	Donnet	141/117
4,094,468	A *	6/1978	Volle	239/394
4,116,216	A *	9/1978	Rosenberg	137/624.13
4,221,334	A *	9/1980	Christopher	239/394
4,290,707	A *	9/1981	Ariga	401/110
5,183,322	A *	2/1993	Haruch	239/394
5,232,161	A *	8/1993	Clemmons	239/346
5,358,180	A *	10/1994	Prassas et al.	239/391
5,386,940	A *	2/1995	Berfield	239/394
5,415,348	A	5/1995	Nelson	
5,762,269	A	6/1998	Sweet	
5,862,543	A *	1/1999	Reynoso et al.	4/541.6
5,884,847	A *	3/1999	Christopher	239/390

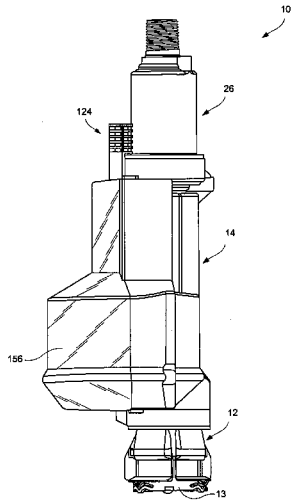
(Continued)

Primary Examiner — Jason Boeckmann
Assistant Examiner — Steven M Cernoch
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

A sprinkler assembly includes a housing having an open side; a sprinkler body supported at one end of the housing and adapted to receive a nozzle. A nozzle magazine is attached to the housing along the open side and holds plural nozzles selectively alignable with said sprinkler body. An actuator is arranged to move a selected one of the plural nozzles from the nozzle magazine into the sprinkler body.

17 Claims, 37 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,364,219	B1 *	4/2002	Zimmerman et al.	239/394
6,398,134	B1 *	6/2002	Hickson et al.	239/394
6,435,427	B1 *	8/2002	Conroy	239/392
6,438,766	B1 *	8/2002	Capdevila Arnau et al.	4/490
6,460,783	B1 *	10/2002	Christopher	239/394
6,651,909	B1 *	11/2003	Bugarin	239/390
6,749,134	B2 *	6/2004	Arenson et al.	239/393
6,772,964	B2 *	8/2004	Funseth et al.	239/436
6,988,677	B2 *	1/2006	Sodemann et al.	239/525
7,080,795	B2 *	7/2006	Chen	239/394
7,370,814	B2 *	5/2008	Chih	239/394
7,472,840	B2 *	1/2009	Gregory	239/289
7,475,833	B2 *	1/2009	Chih	239/394
7,717,131	B2 *	5/2010	Creswell et al.	137/625.46
7,980,490	B2 *	7/2011	Waddelow et al.	239/394
2002/0092928	A1 *	7/2002	Conroy	239/392
2012/0312898	A1 *	12/2012	Sesser et al.	239/394
2013/0015266	A1 *	1/2013	Riley et al.	239/302

* cited by examiner

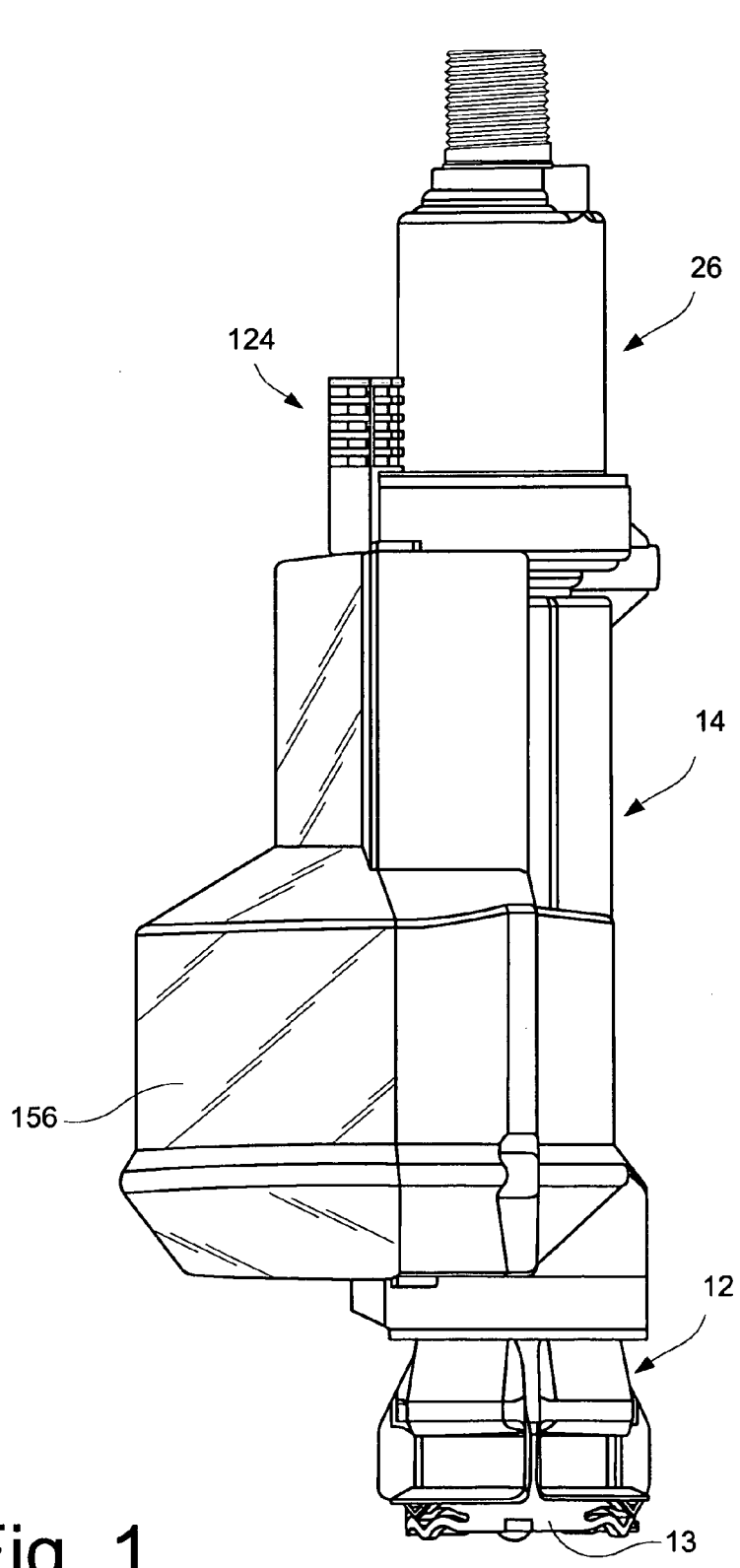


Fig. 1

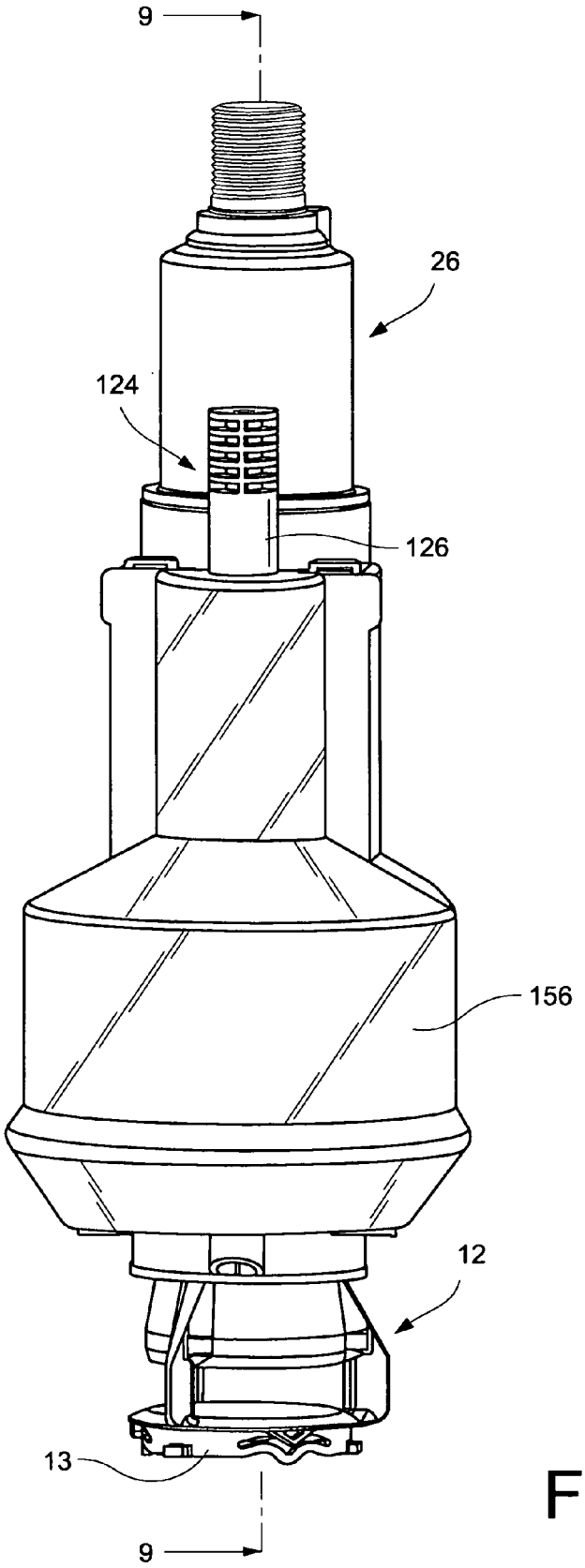


Fig. 2

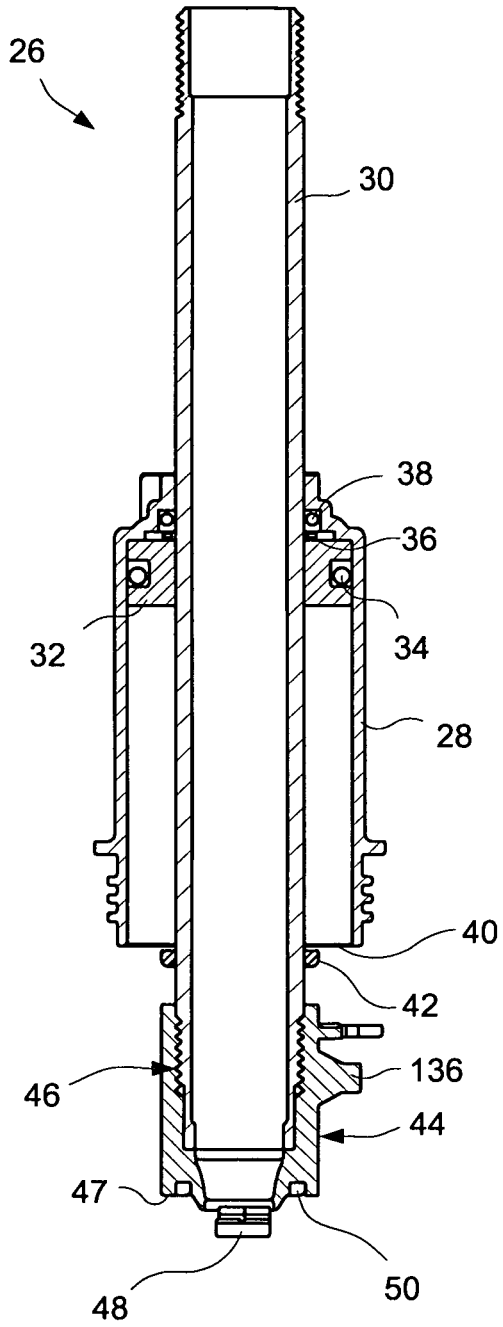


Fig. 3

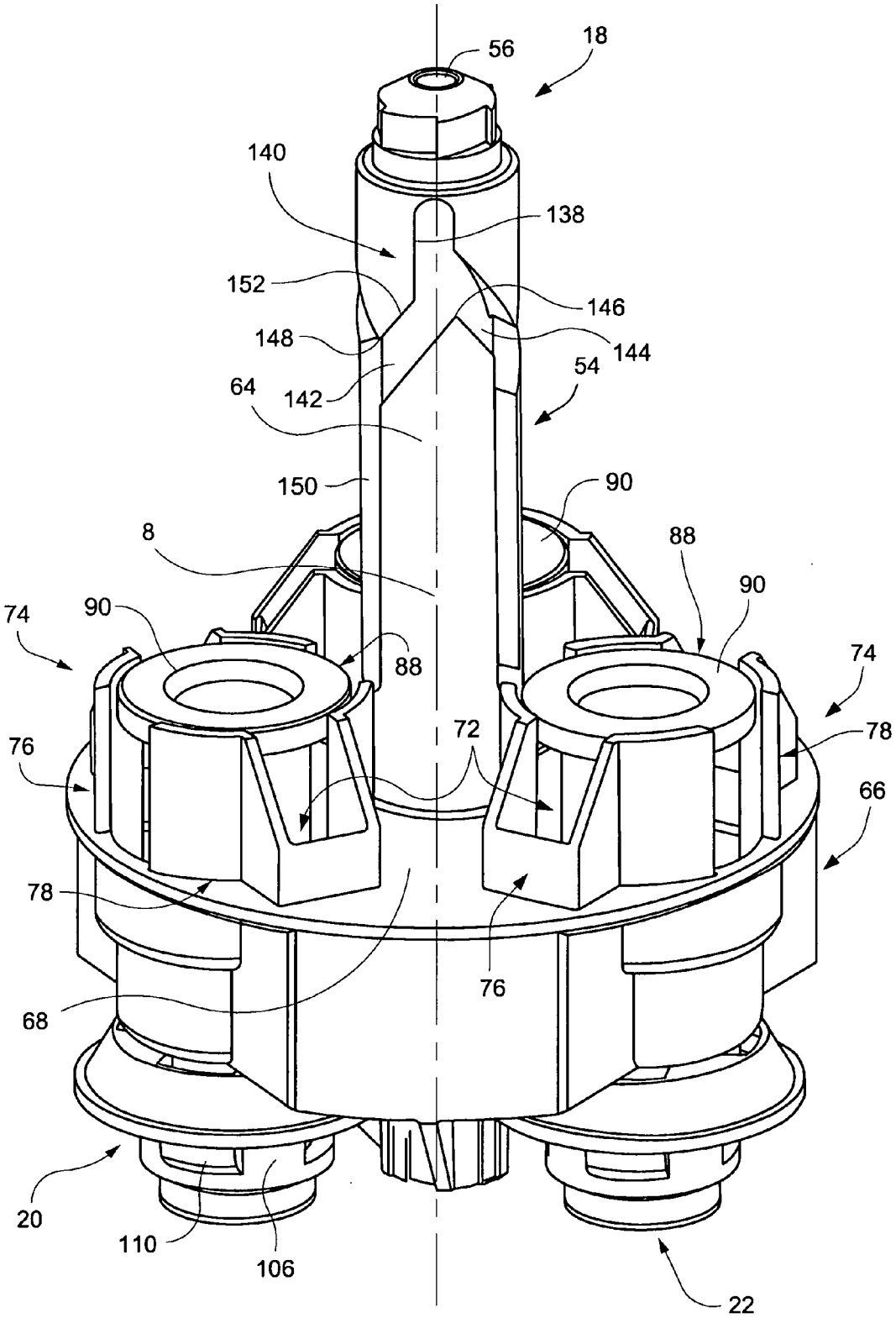

56
18
140
138
152
146
148
144
54
64
142
150
90
8
88
90
74
90
88
74
72
78
76
66
78
76
68
20
110
106
22

Fig. 4

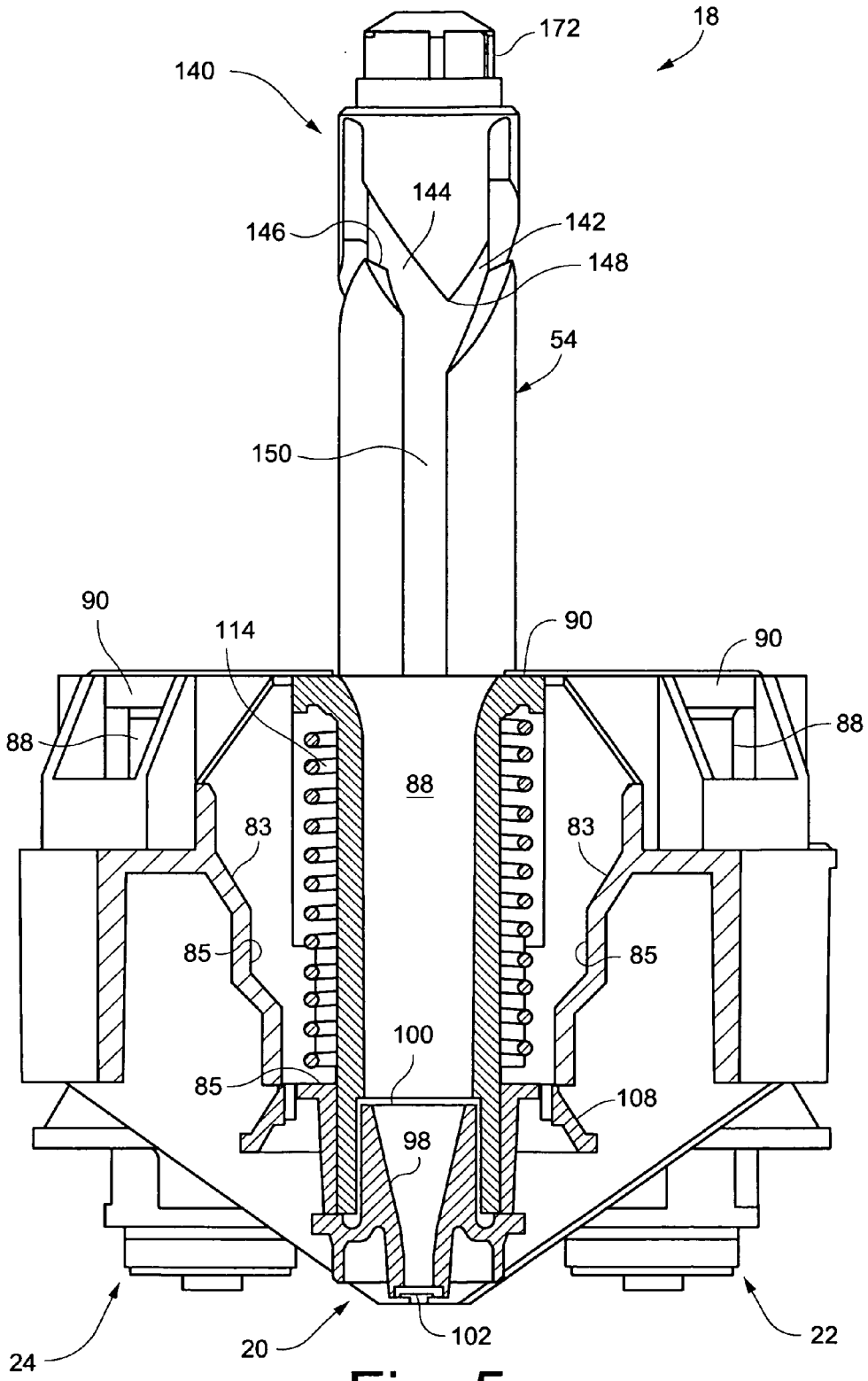

18
172
140
144
146
142
148
54
150
90
114
90
90
88
88
88
83
83
85
85
100
85
108
98
102
24
20
22

Fig. 5

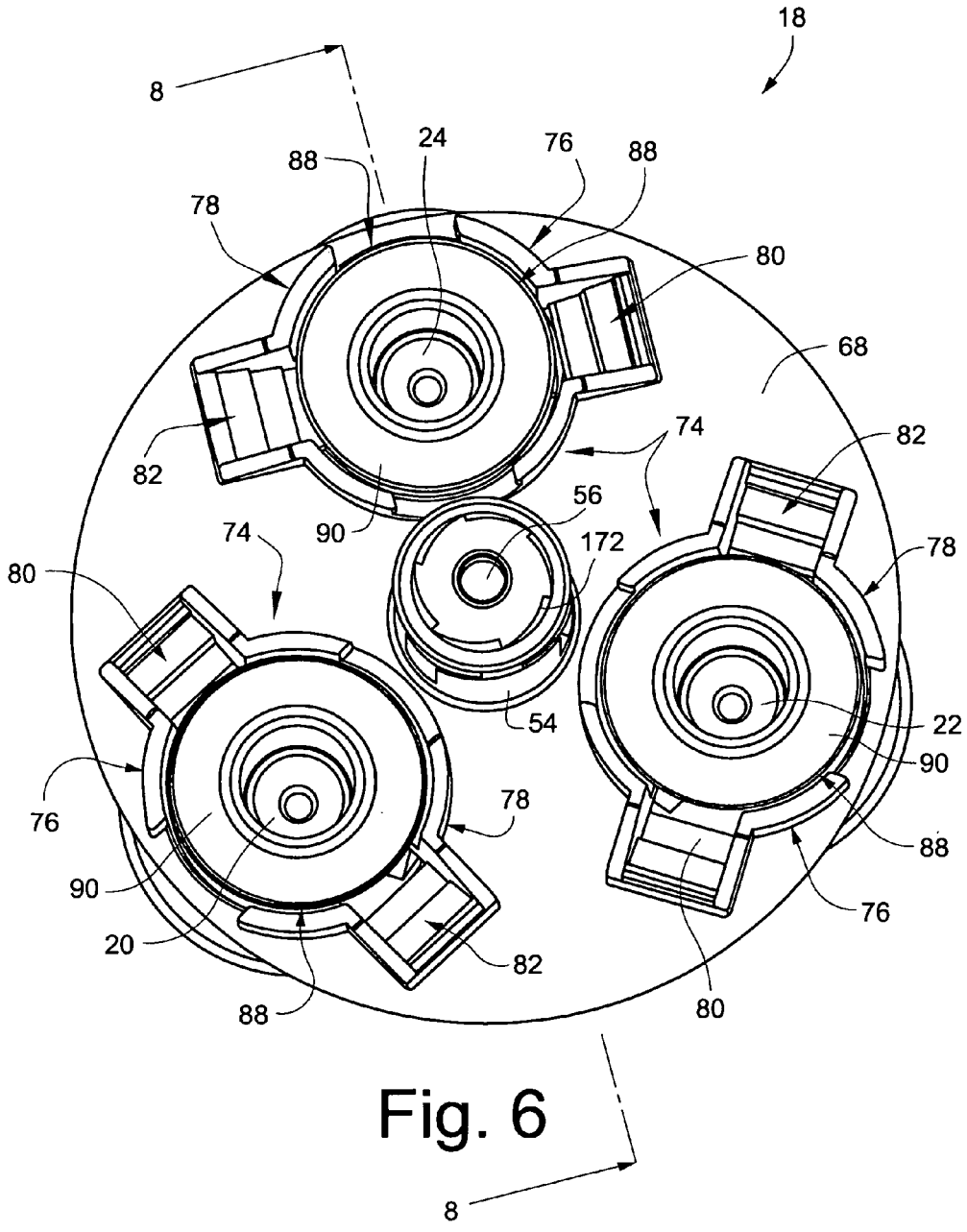

18
8
24
88
76
88
78
80
68
82
74
82
56
90
74
172
78
80
54
22
90
76
78
88
90
76
20
82
88
80
8

Fig. 6

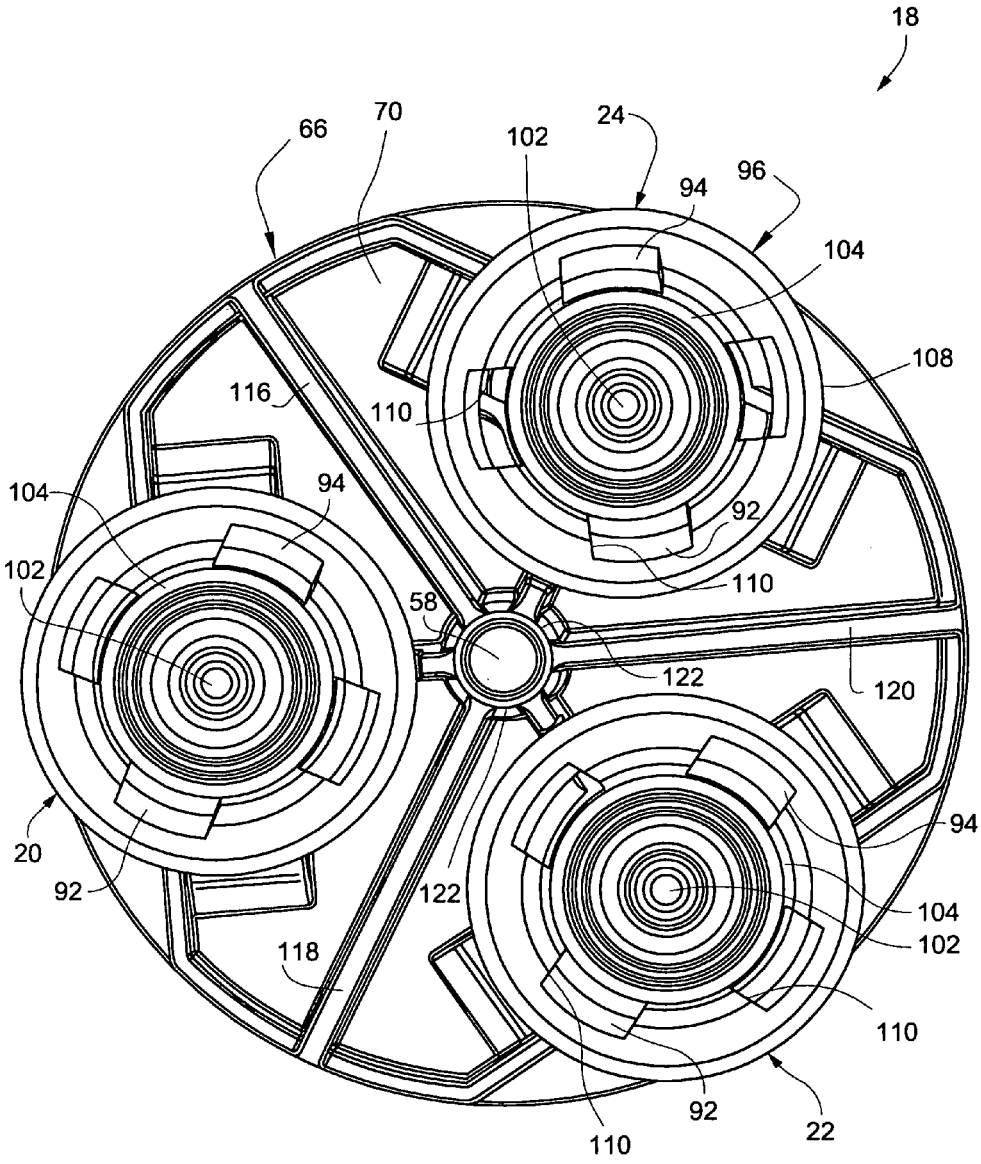

18
66
70
102
24
94
96
104
108
116
110
104
94
92
102
110
58
122
120
20
92
122
94
104
102
118
110
92
22
110

Fig. 7

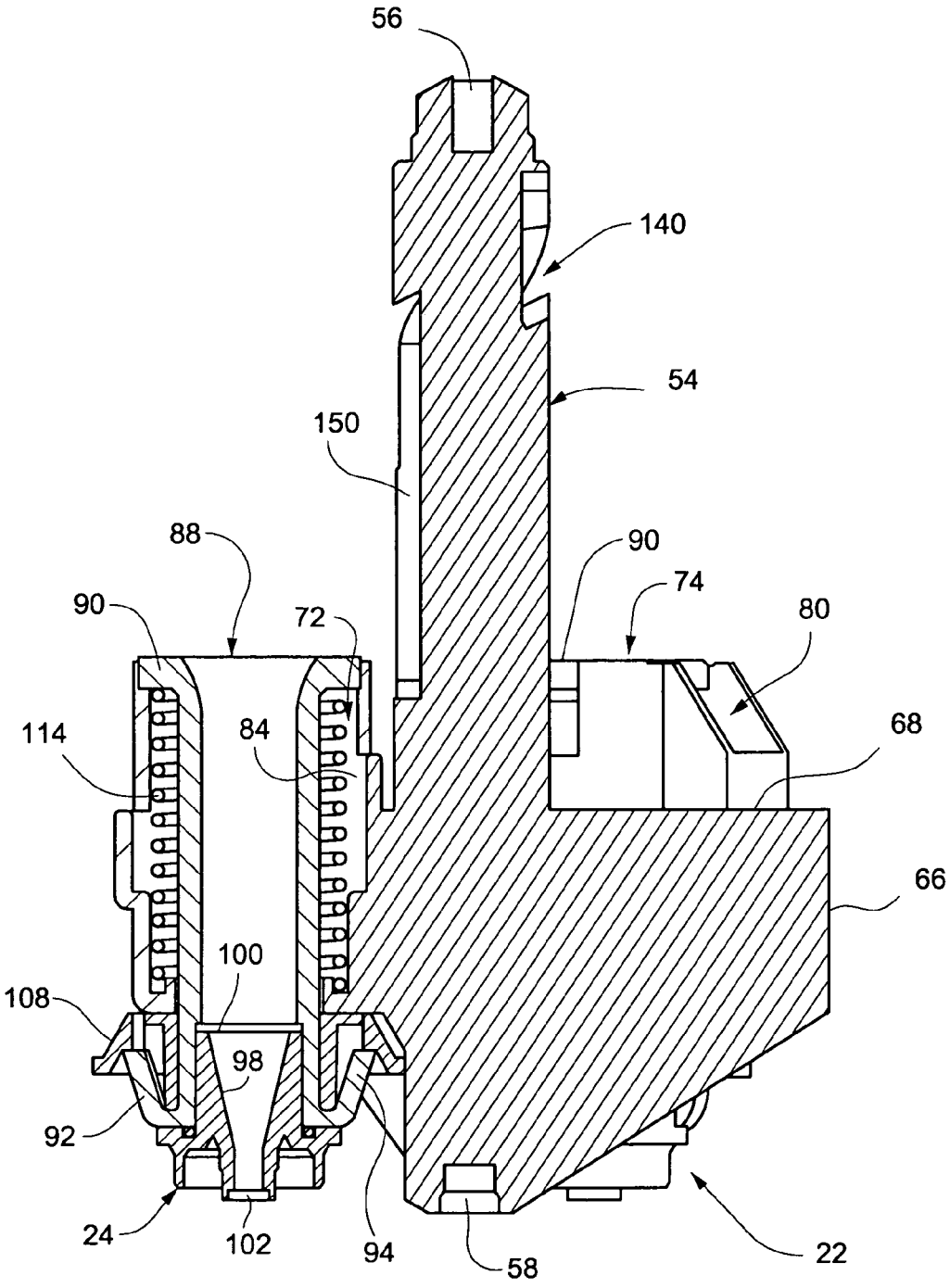

56
140
54
150
88
90
74
80
90
72
114
84
68
66
100
108
98
92
24
102
94
58
22

Fig. 8

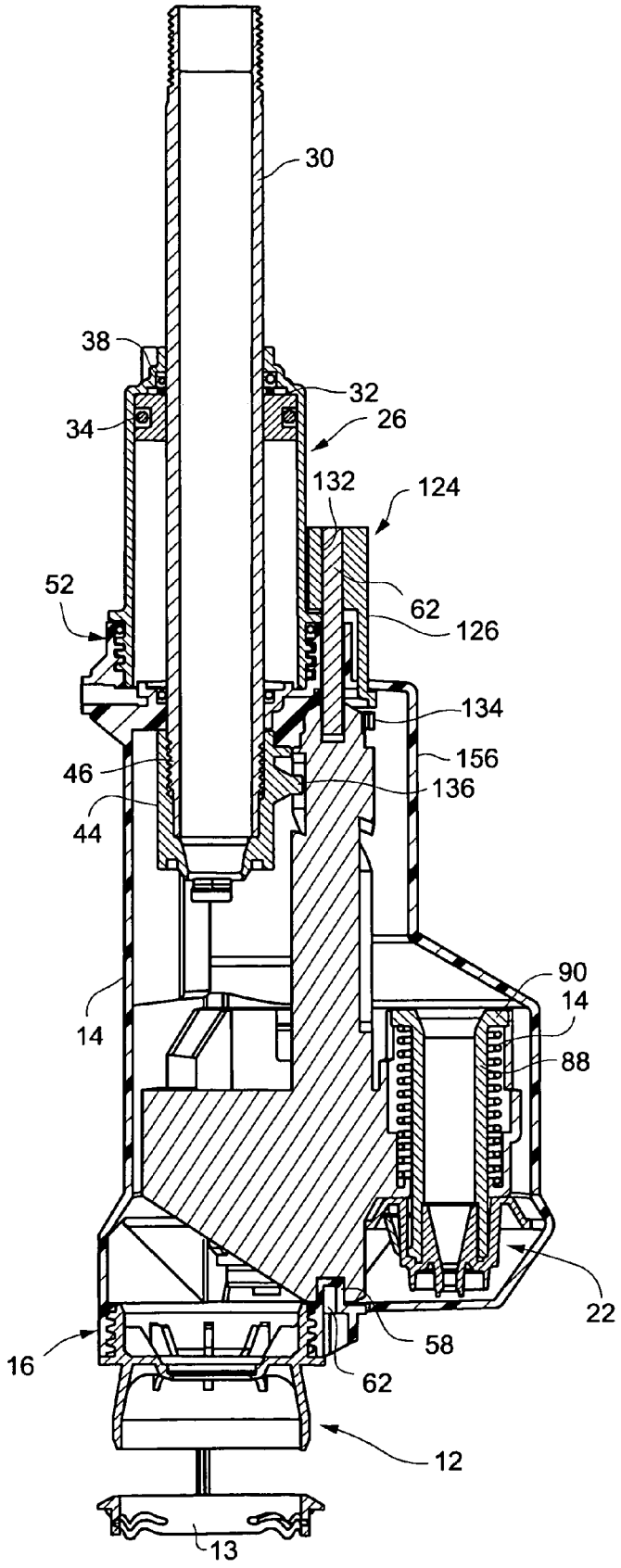

30
38
32
34
26
132
124
52
62
126
134
156
46
136
44
14
90
14
88
22
16
58
62
12
13

Fig. 9

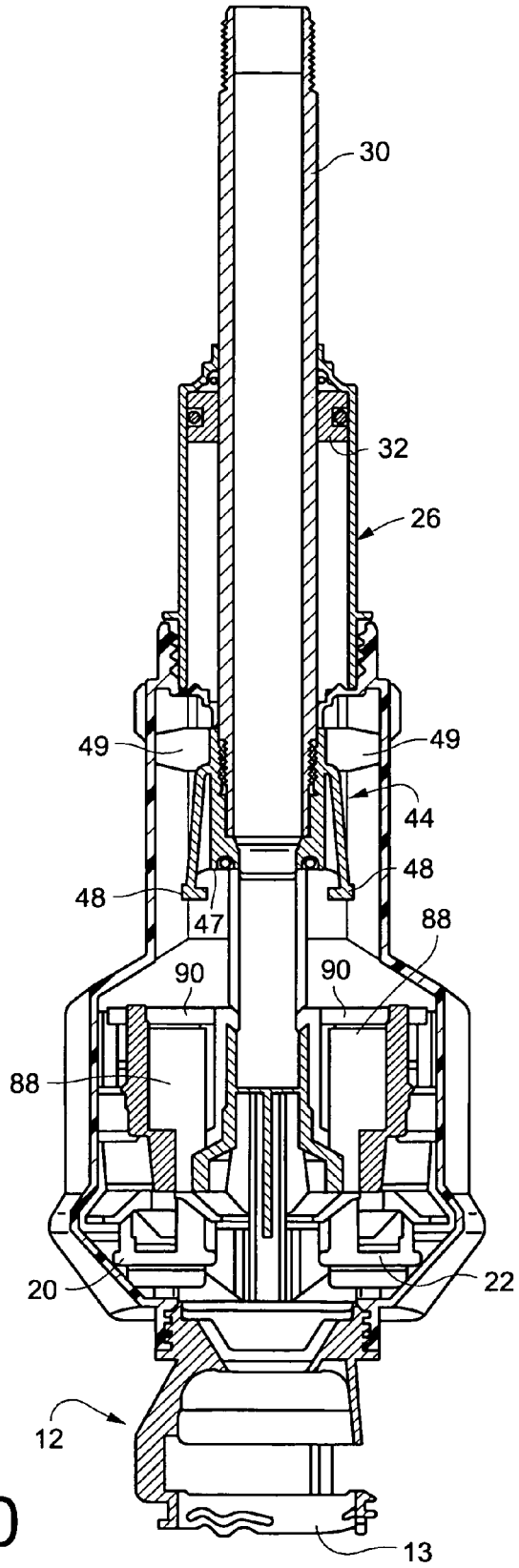


Fig. 10

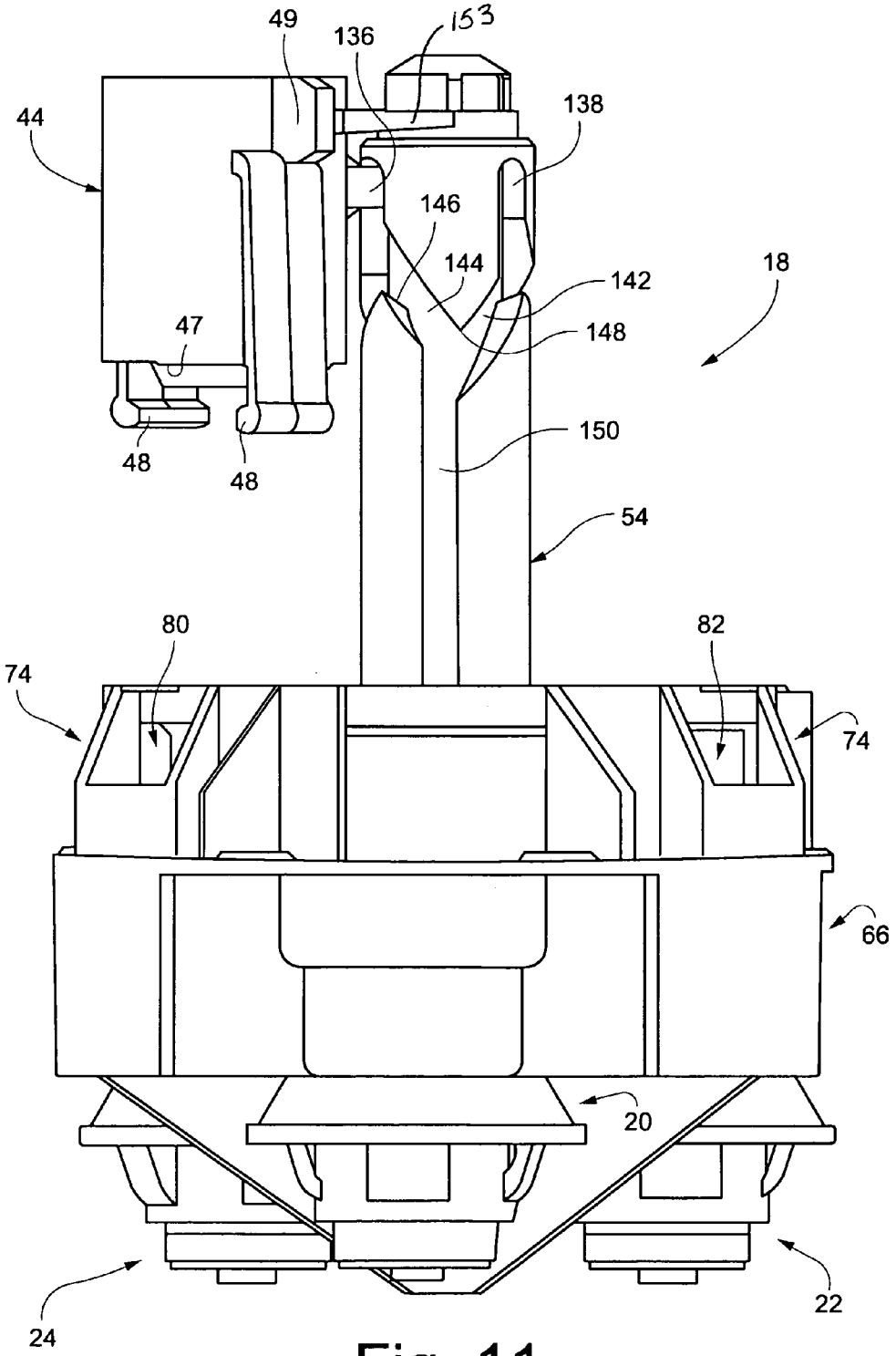

49
136
153
44
138
146
144
142
18
47
148
150
48
48
54
80
82
74
74
66
20
24
22

Fig. 11

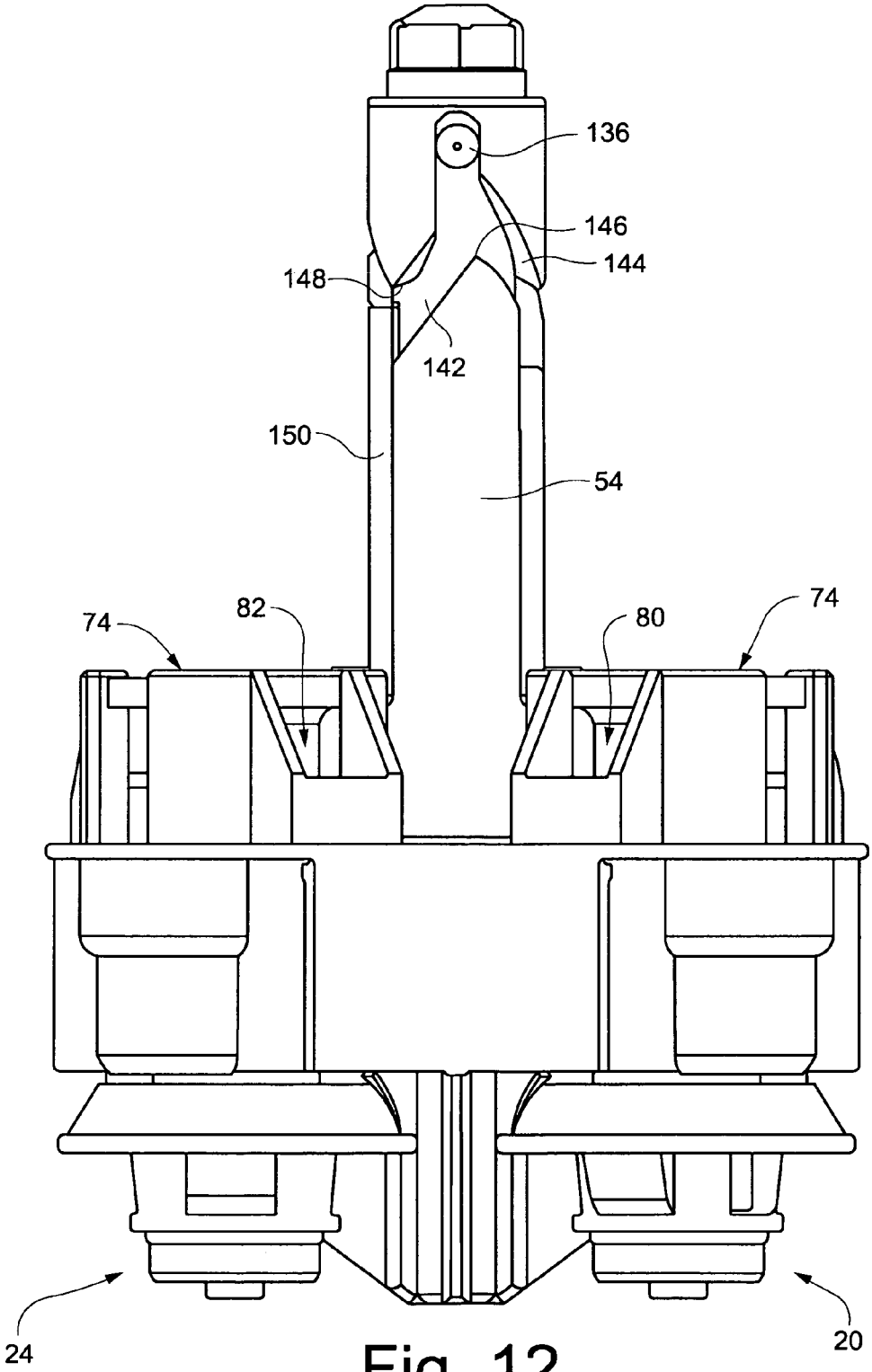


Fig. 12

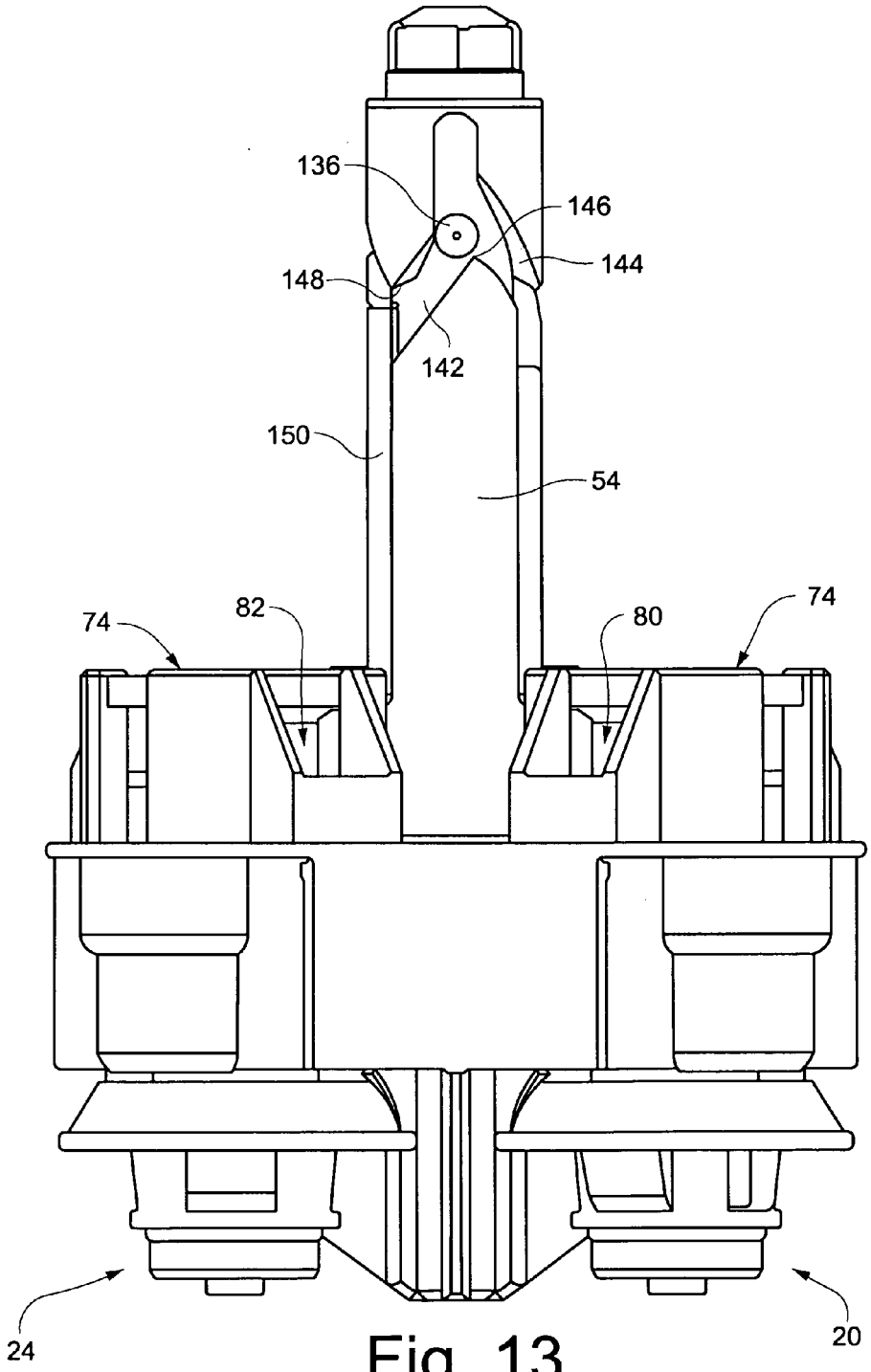


Fig. 13

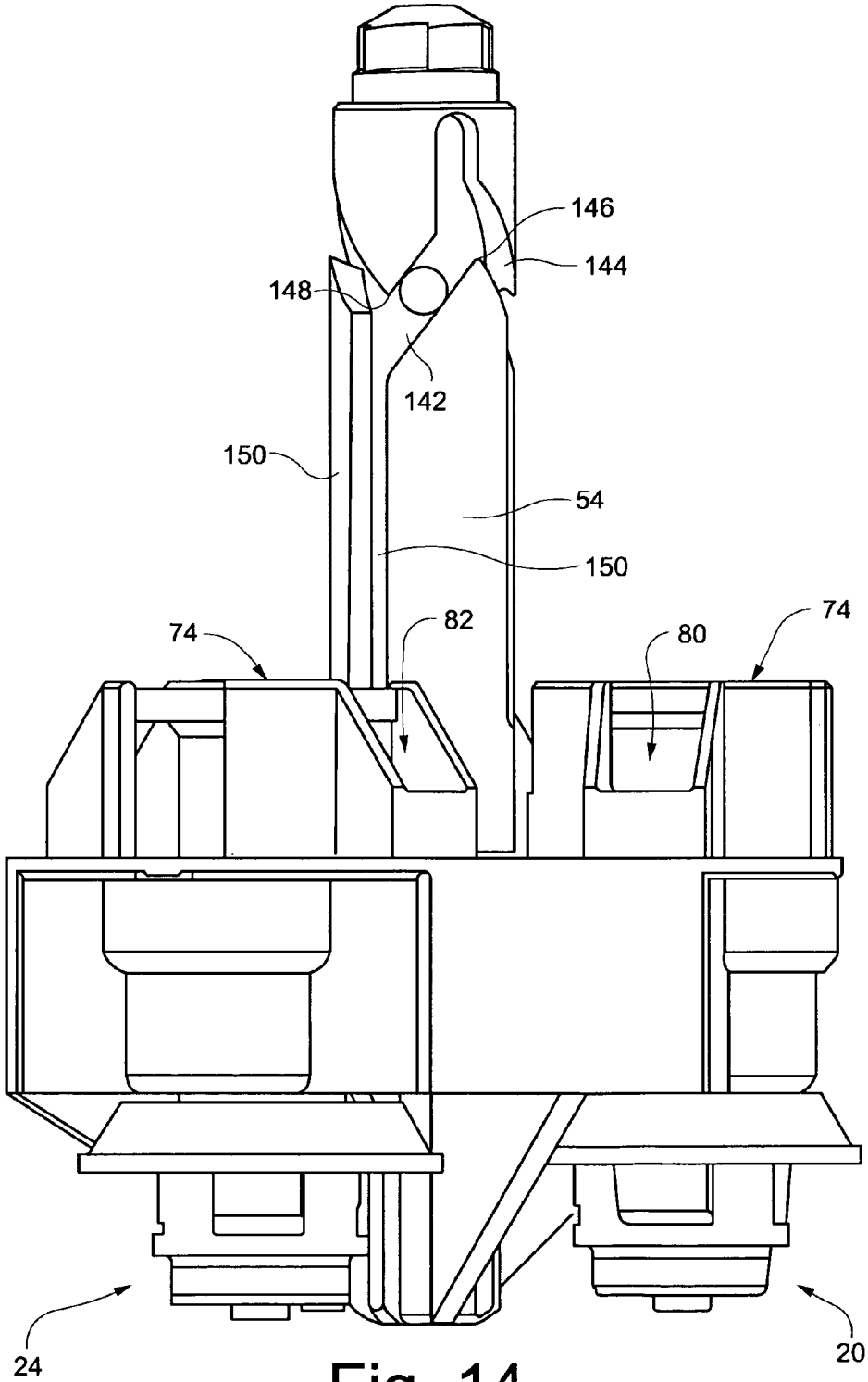


Fig. 14

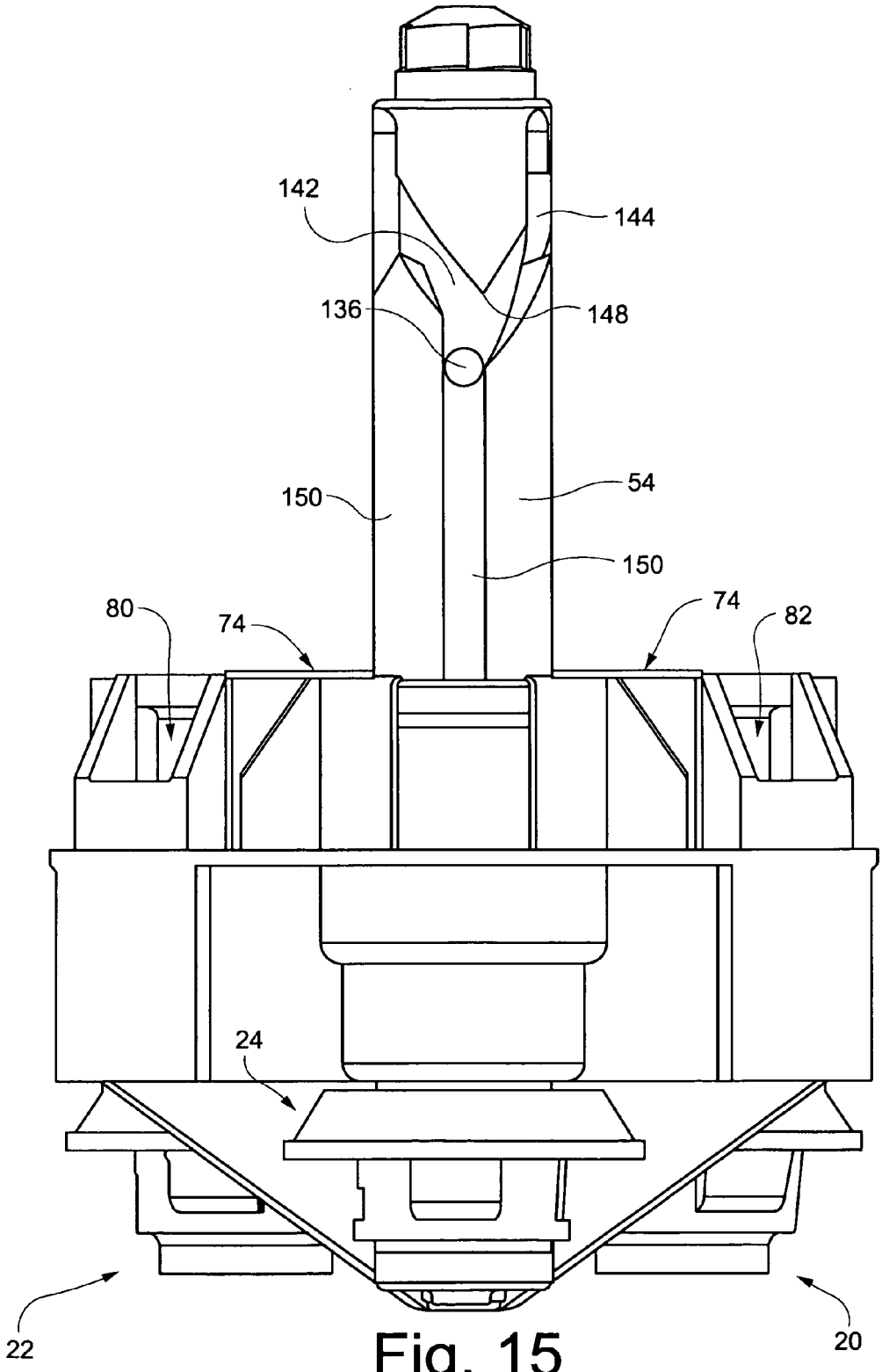


Fig. 15

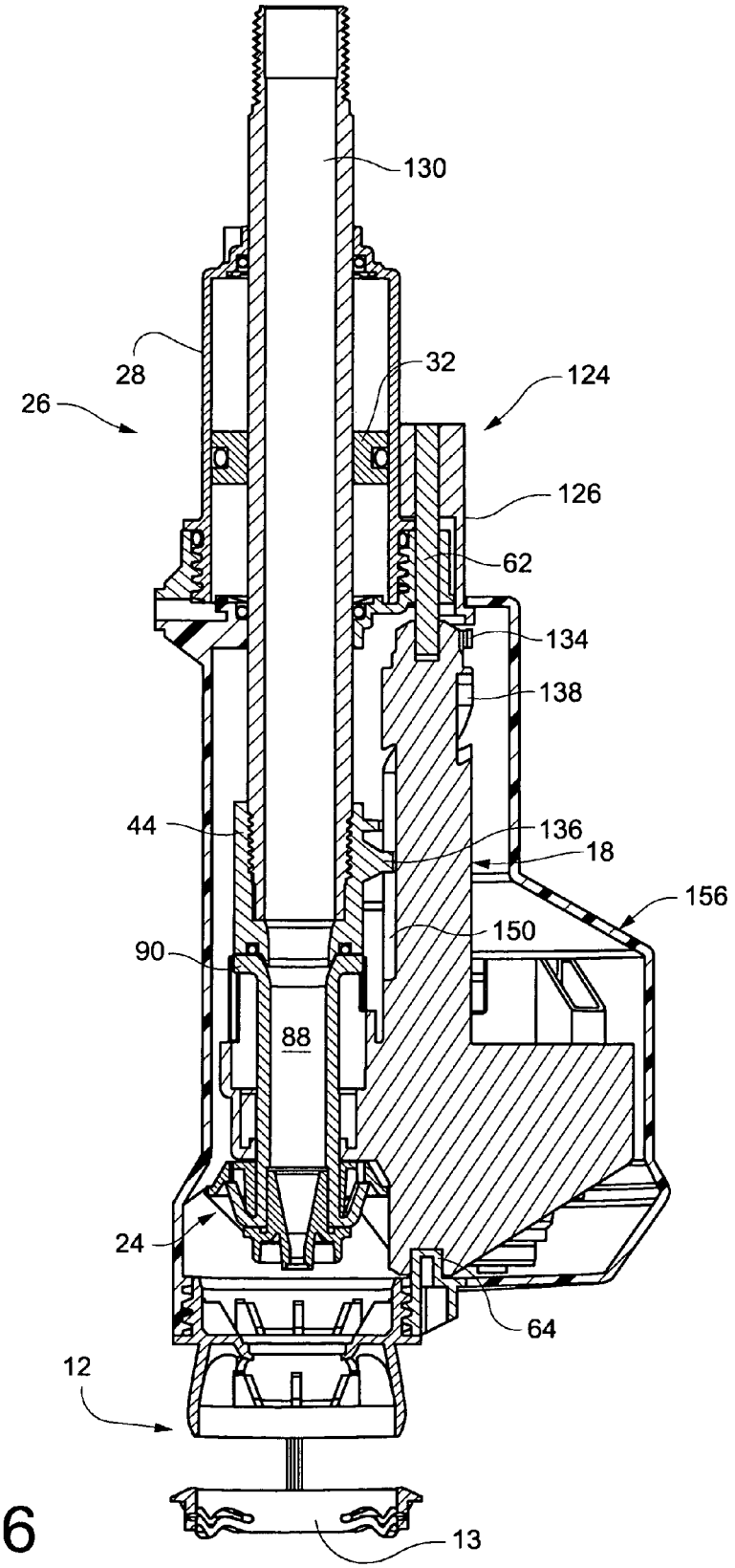


Fig. 16

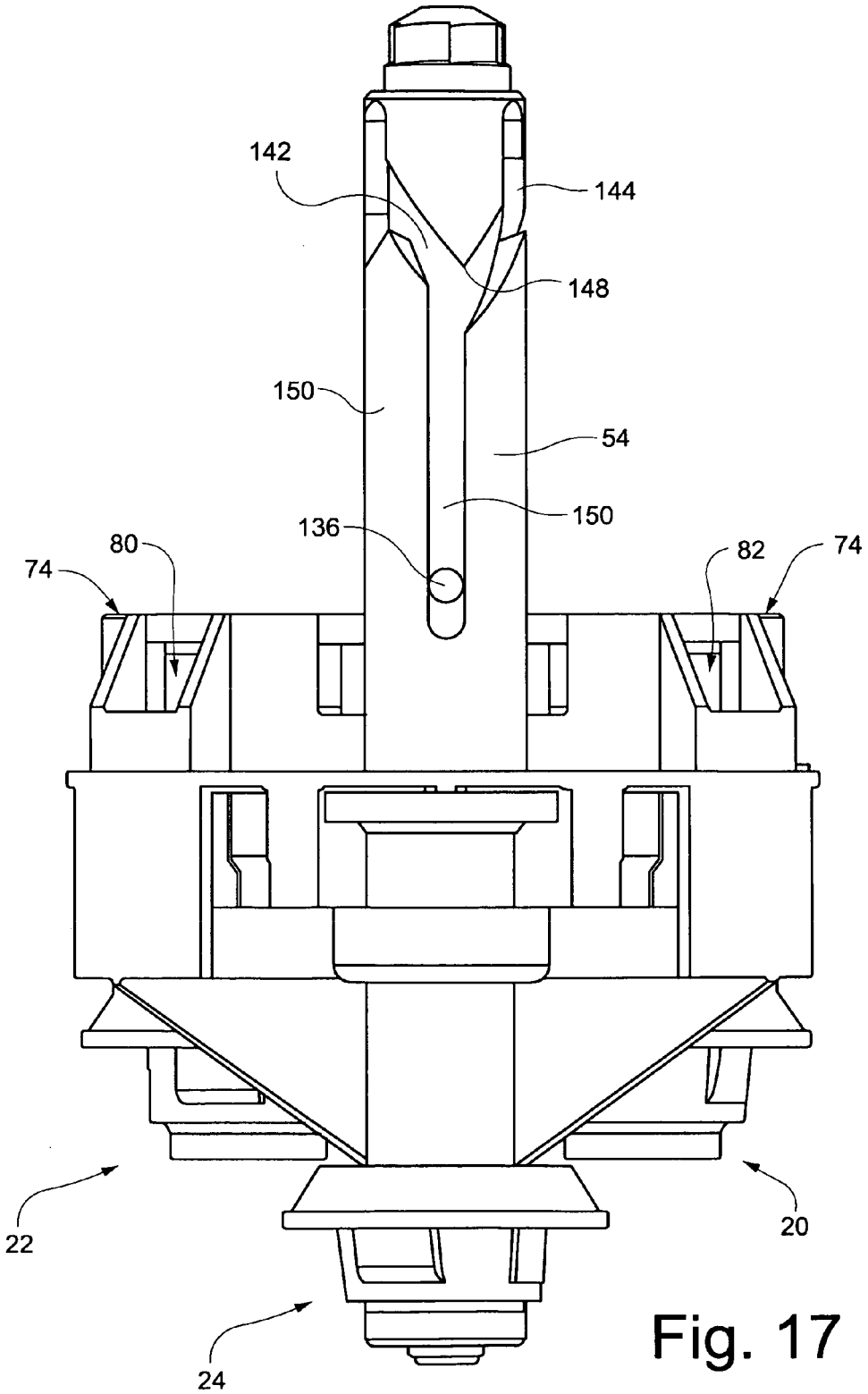


Fig. 17

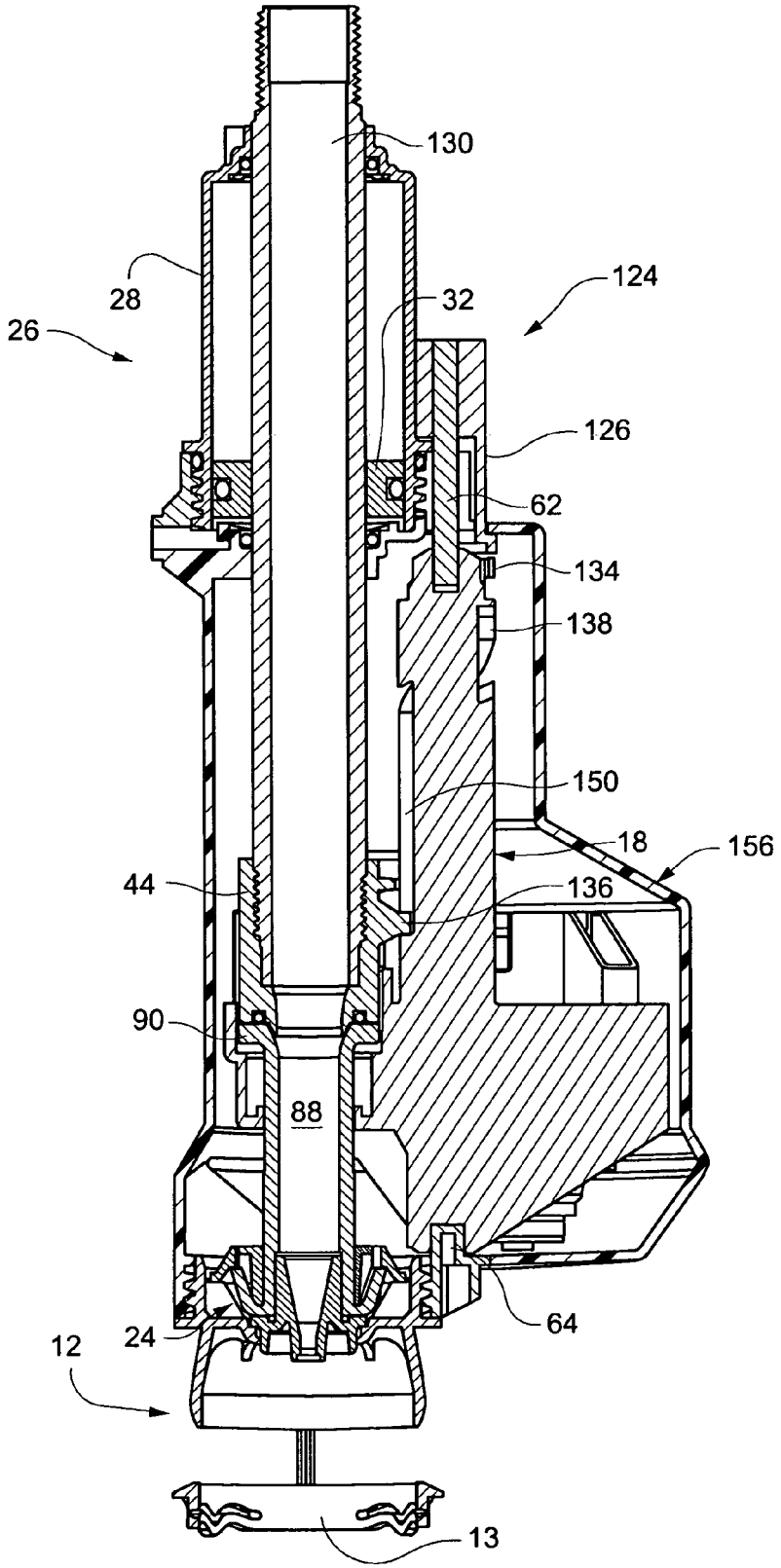


Fig. 18

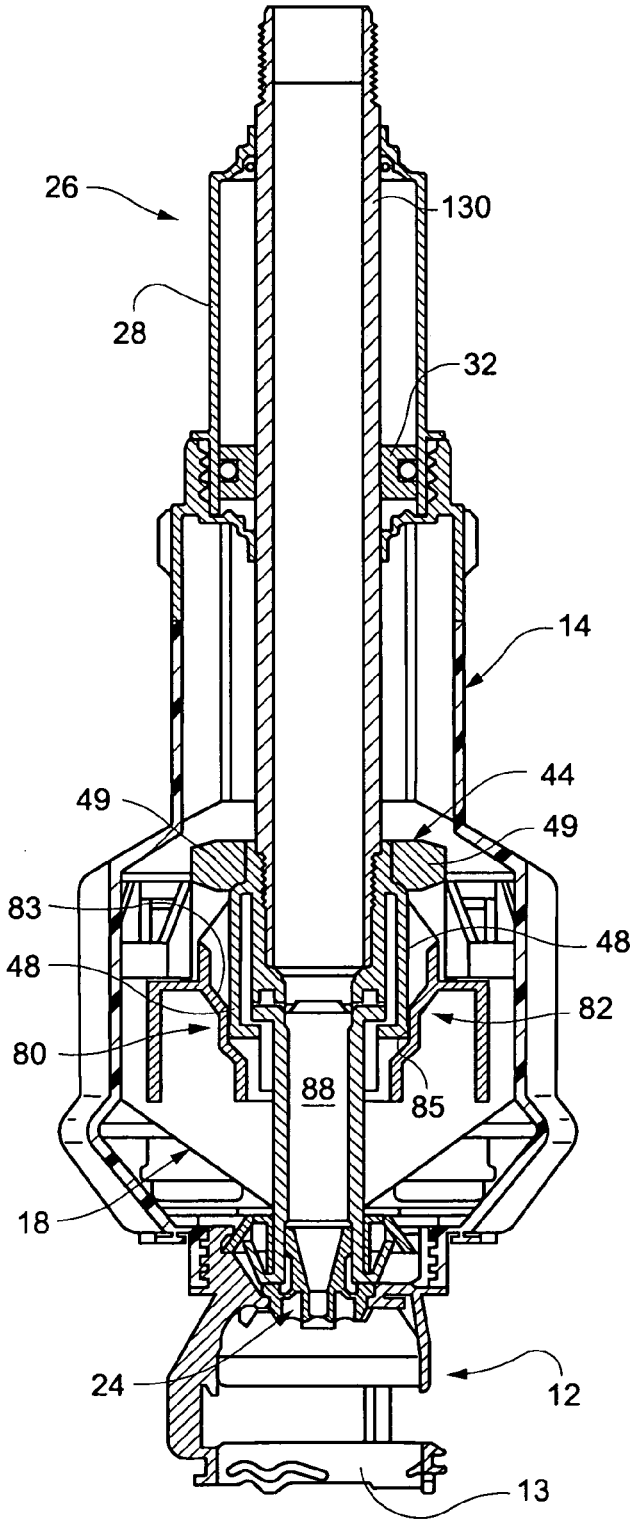


Fig. 19

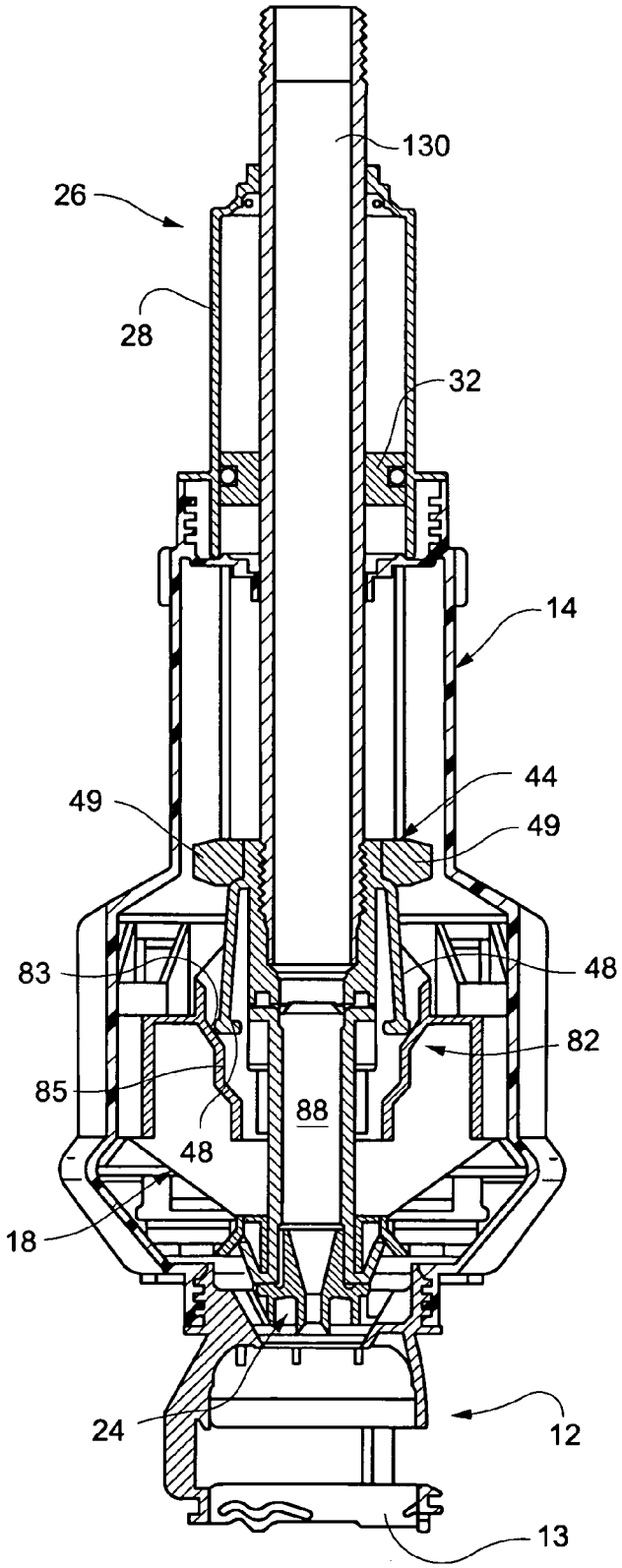


Fig. 20

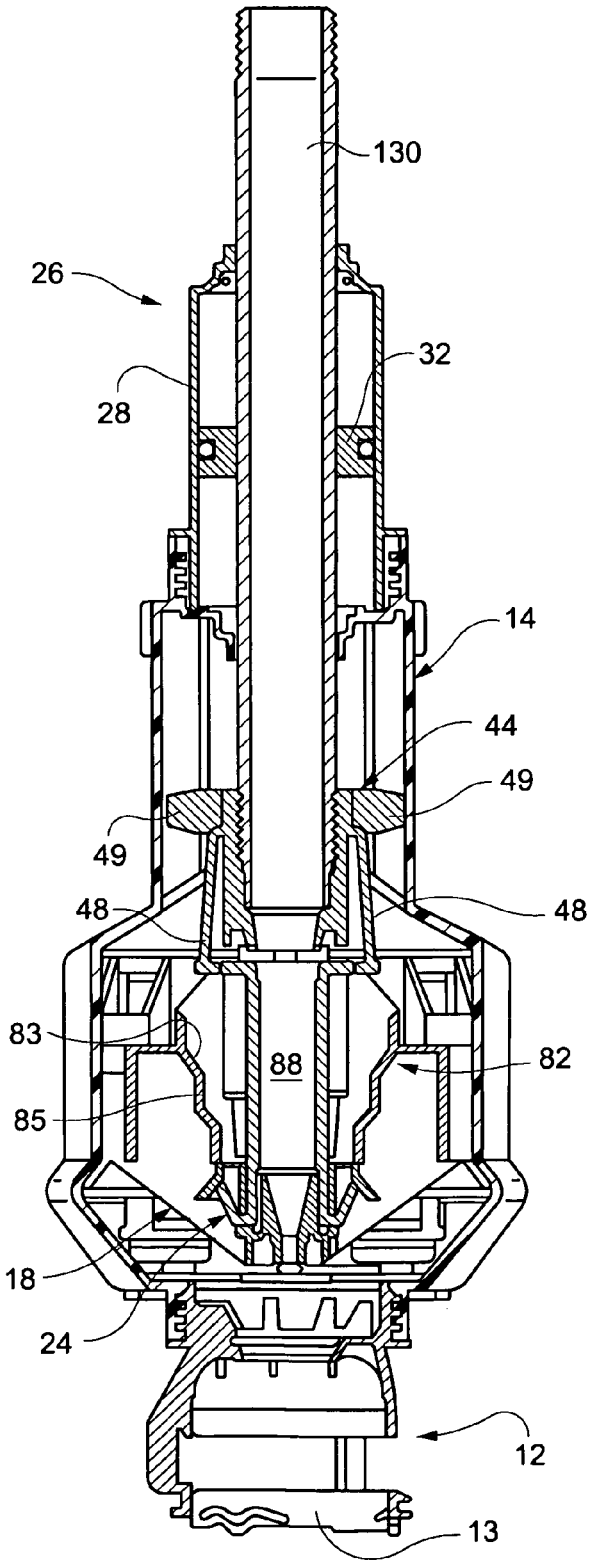


Fig. 21

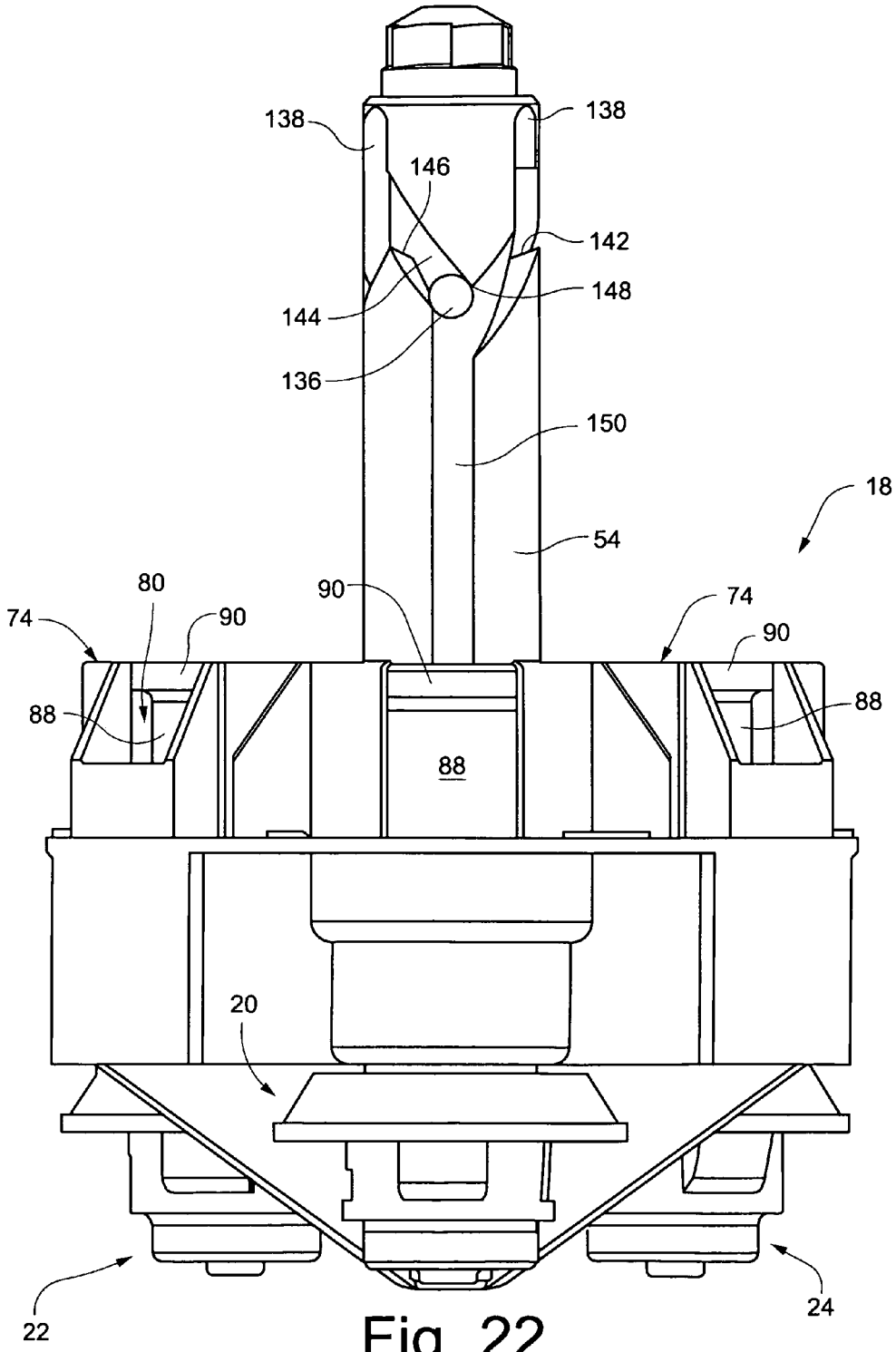

138
138
146
142
148
144
136
150
18
54
80
90
74
90
74
90
88
88
88
20
22
24

Fig. 22

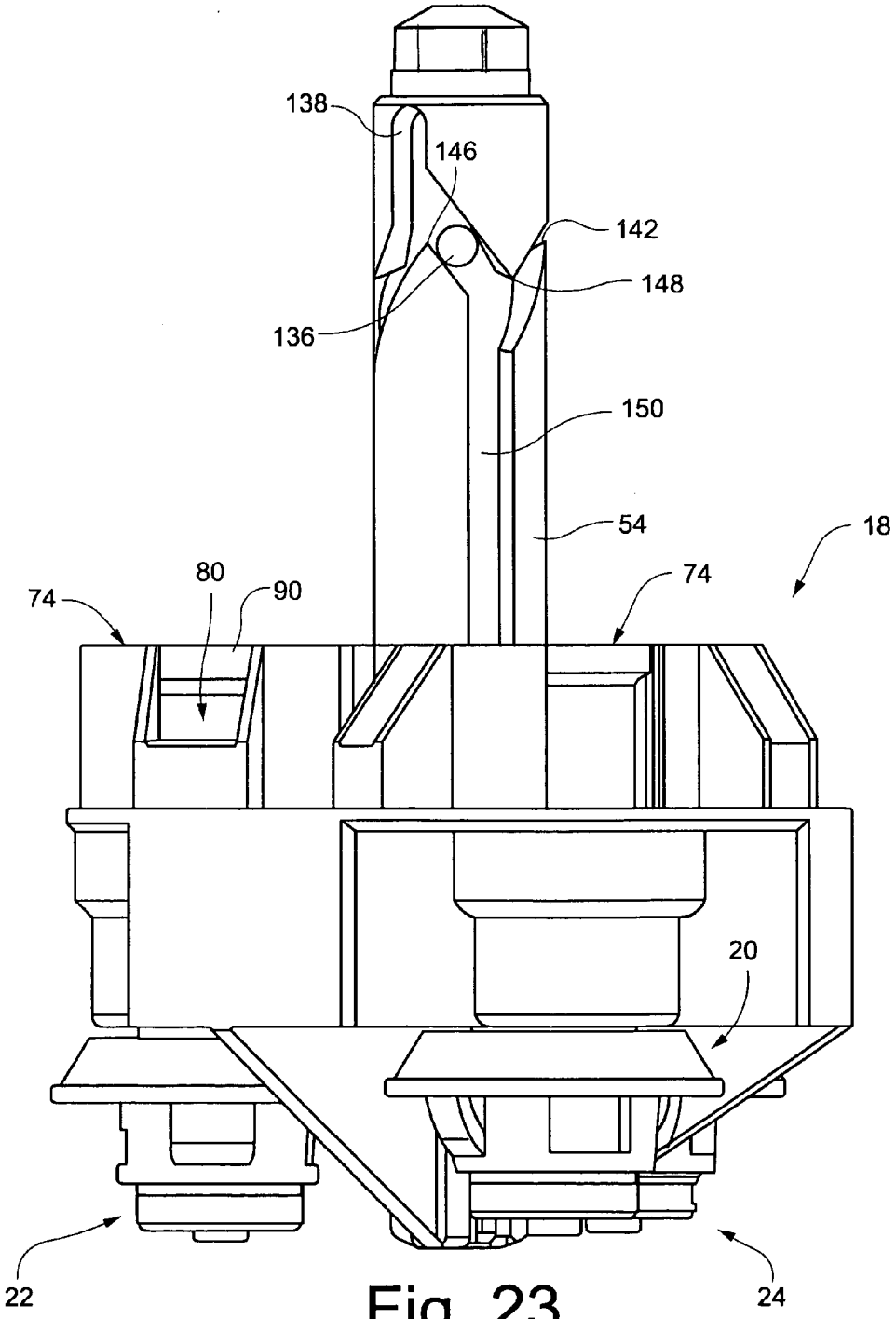


Fig. 23

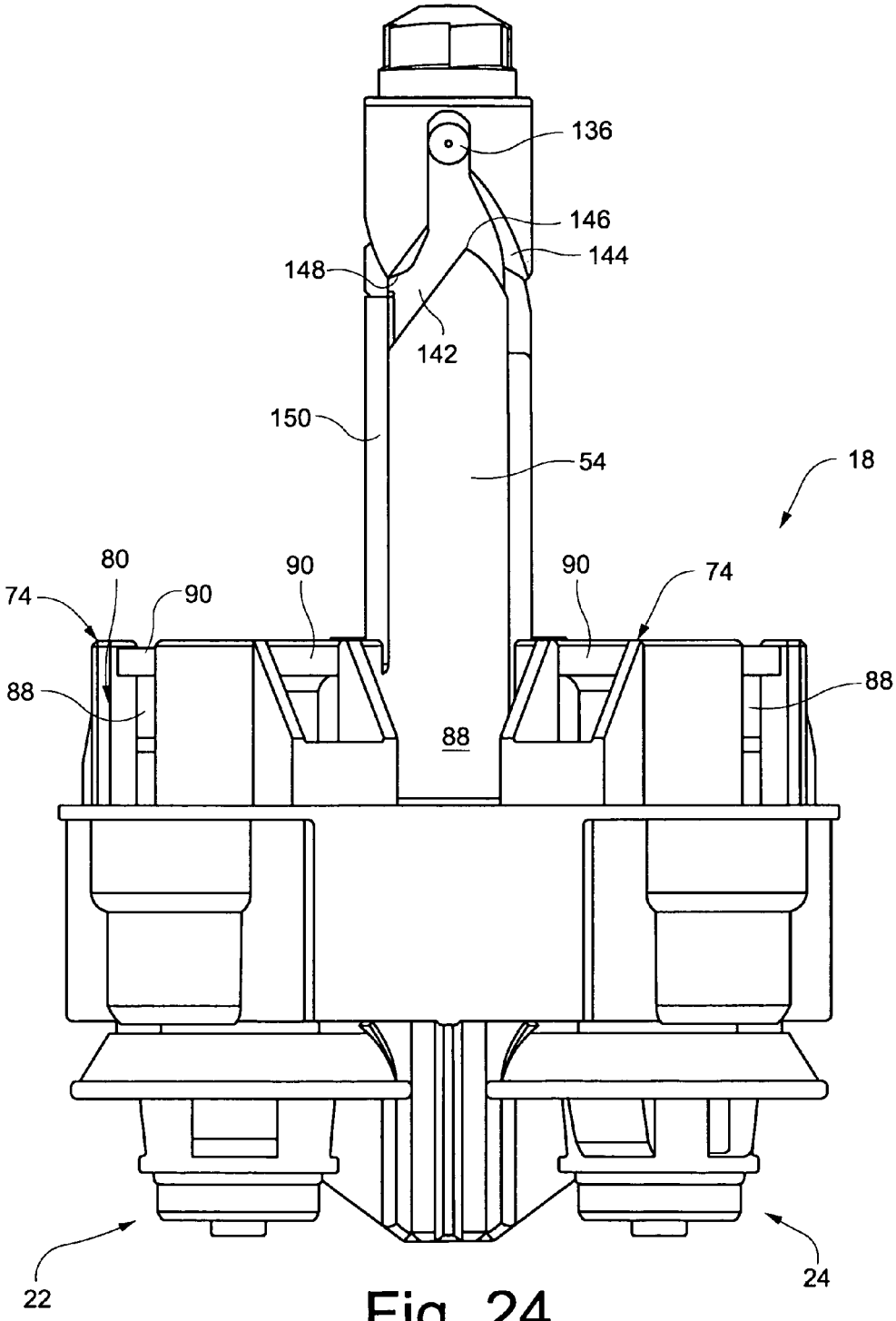


Fig. 24

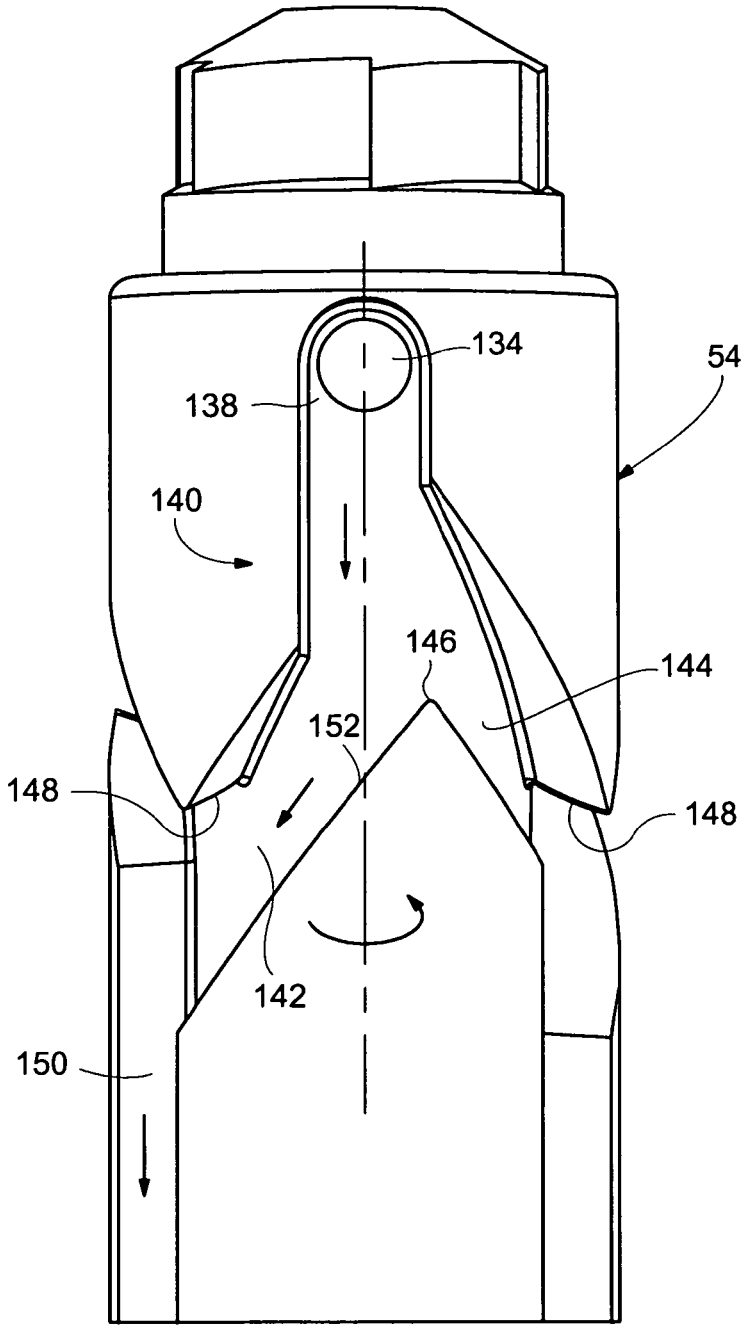


Fig. 25

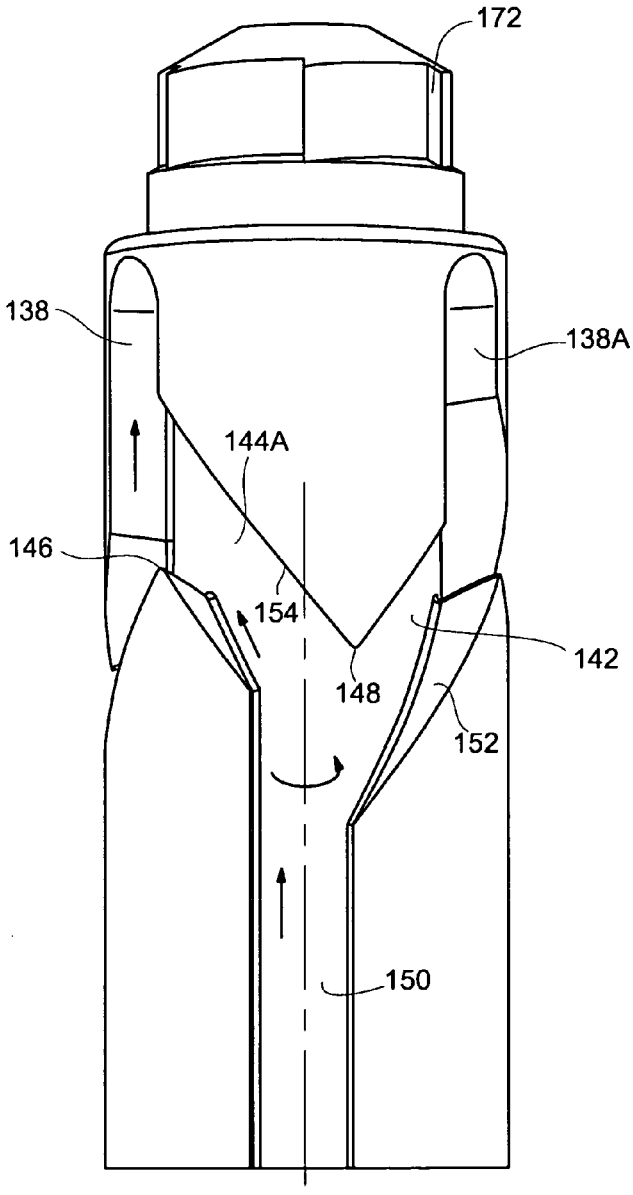


Fig. 26

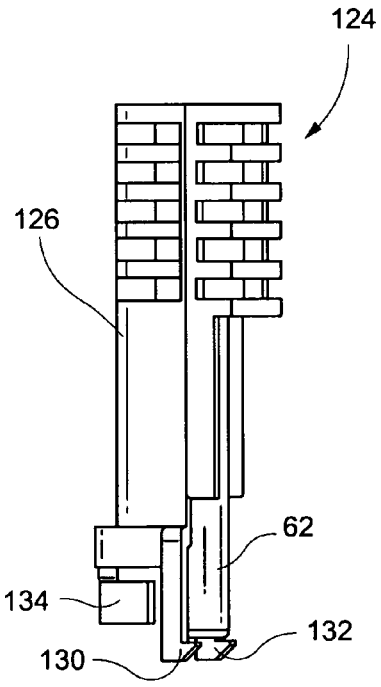


Fig. 27

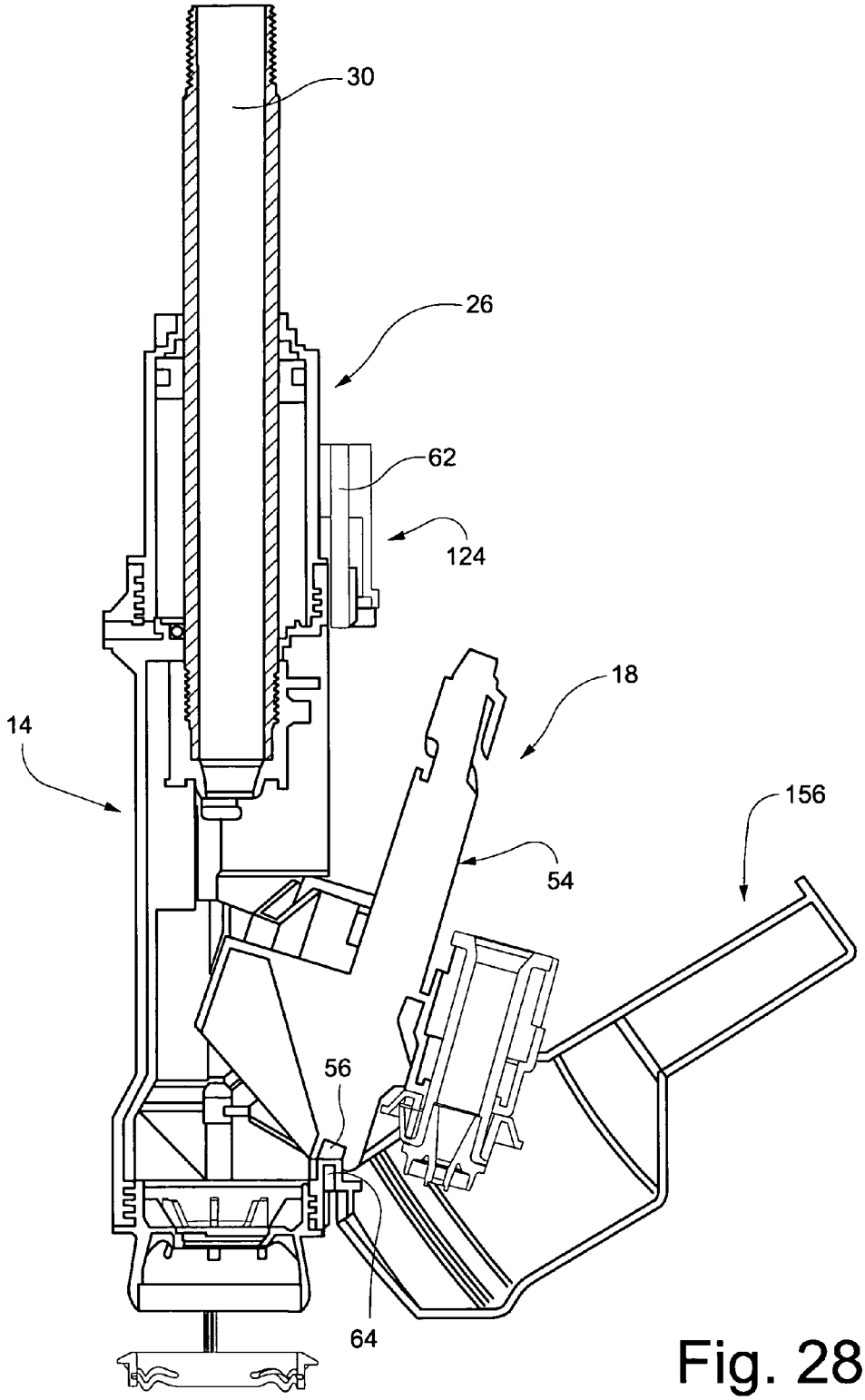


Fig. 28

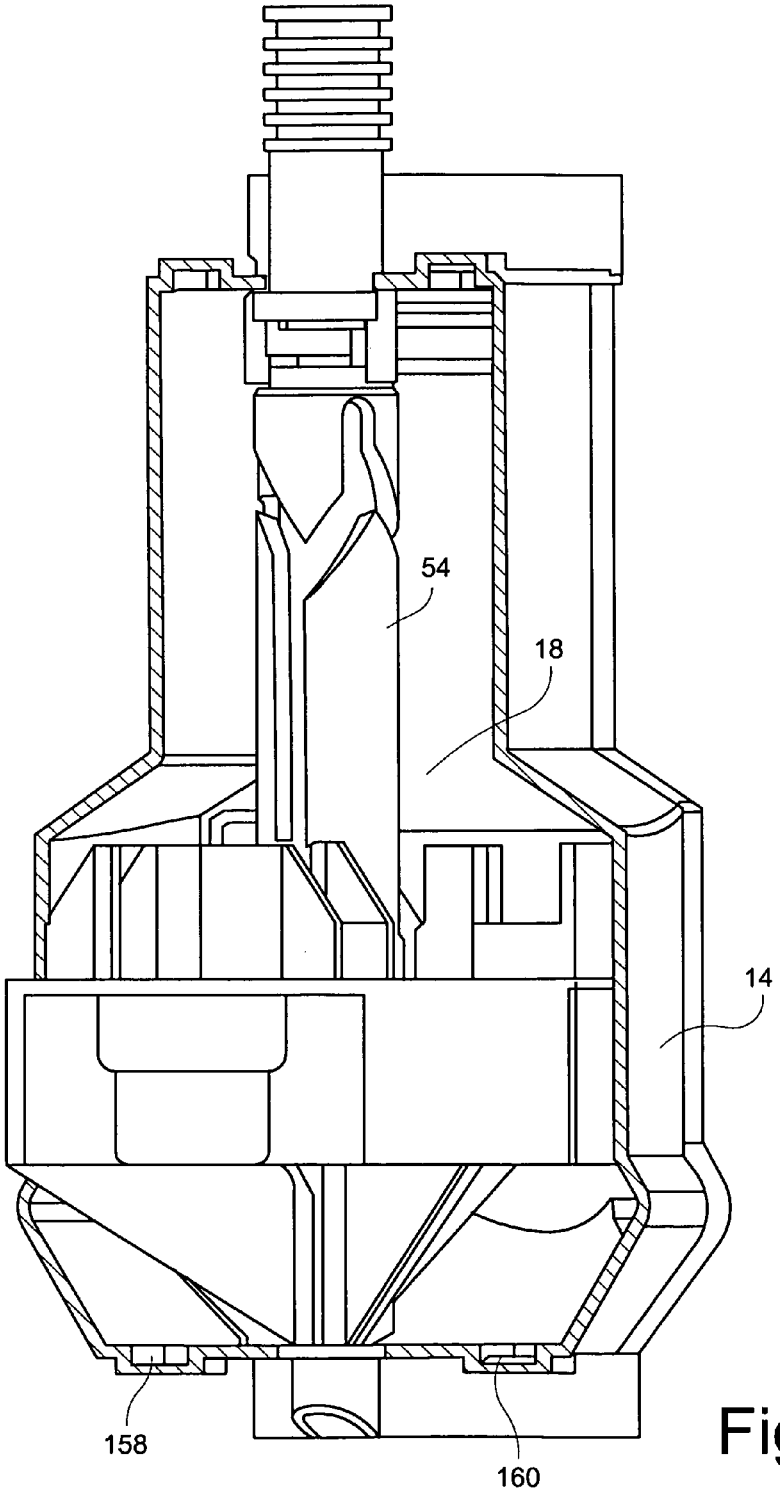


Fig. 29

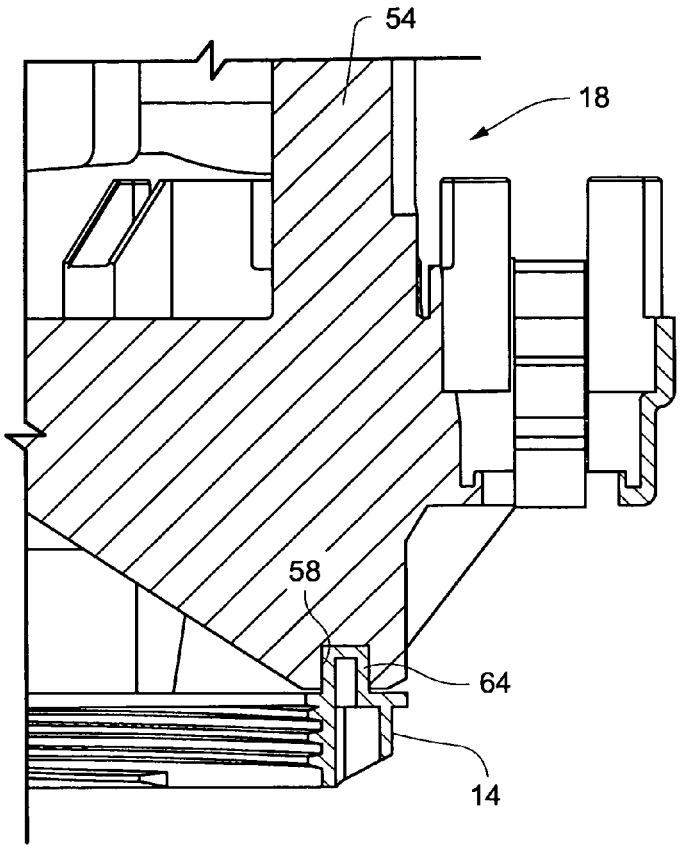


Fig. 30

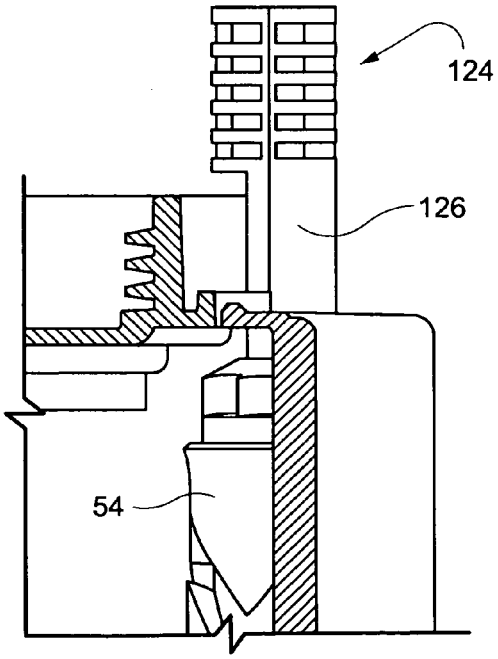


Fig. 31

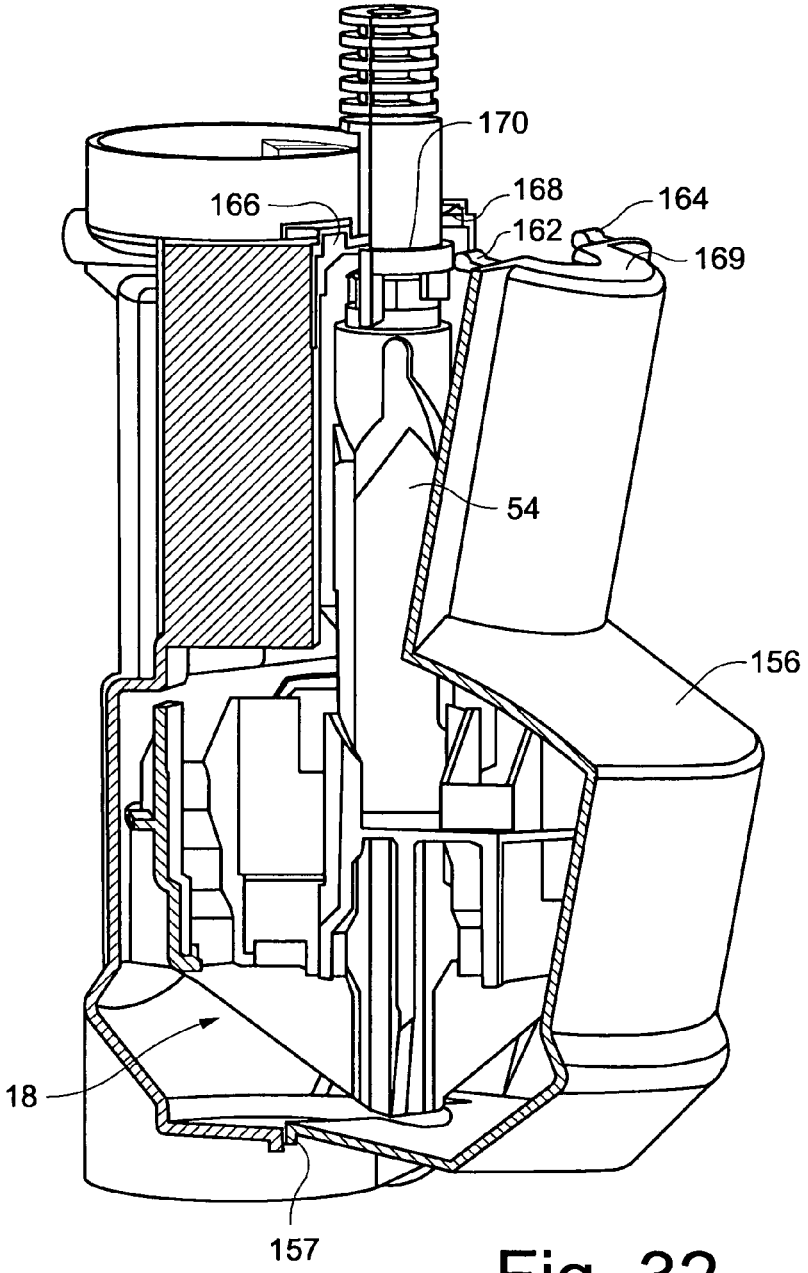


Fig. 32

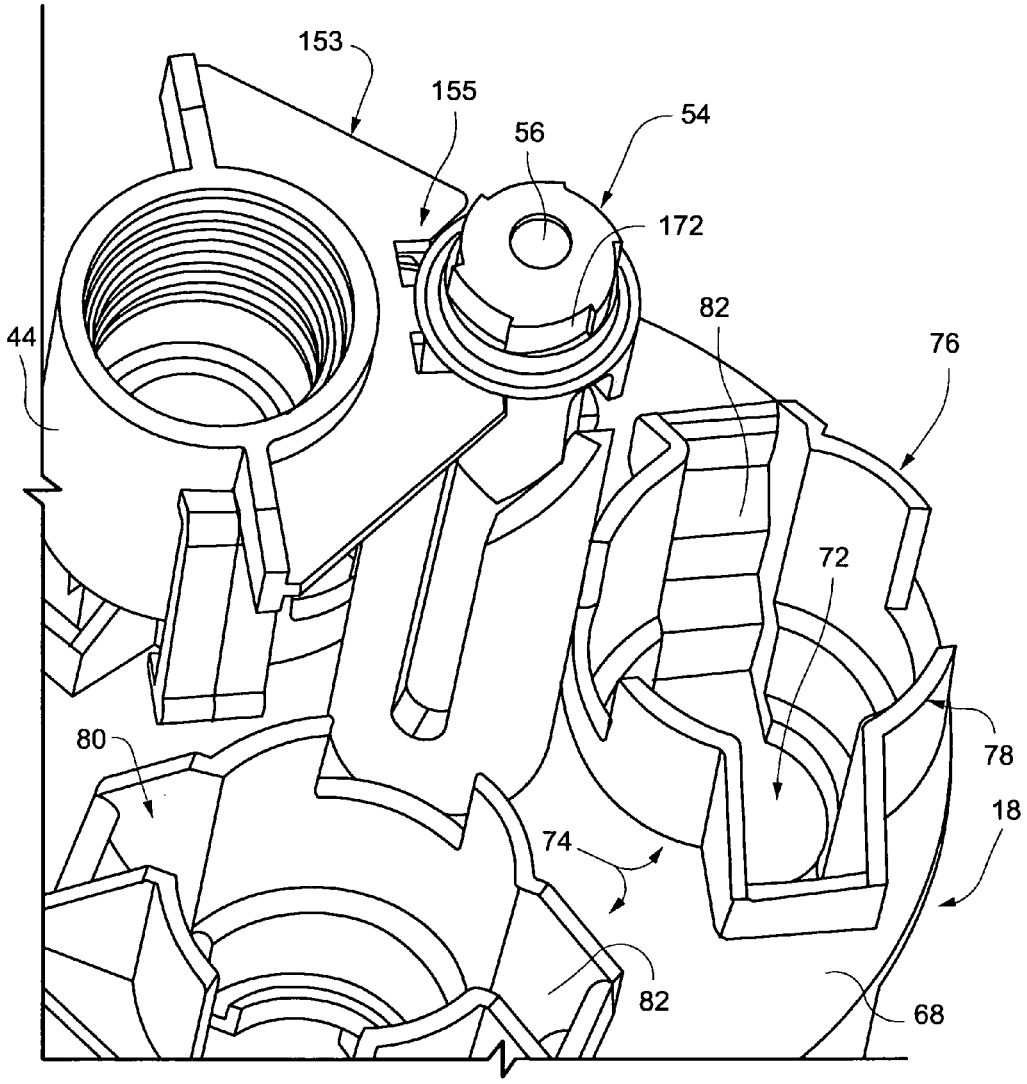


Fig. 33

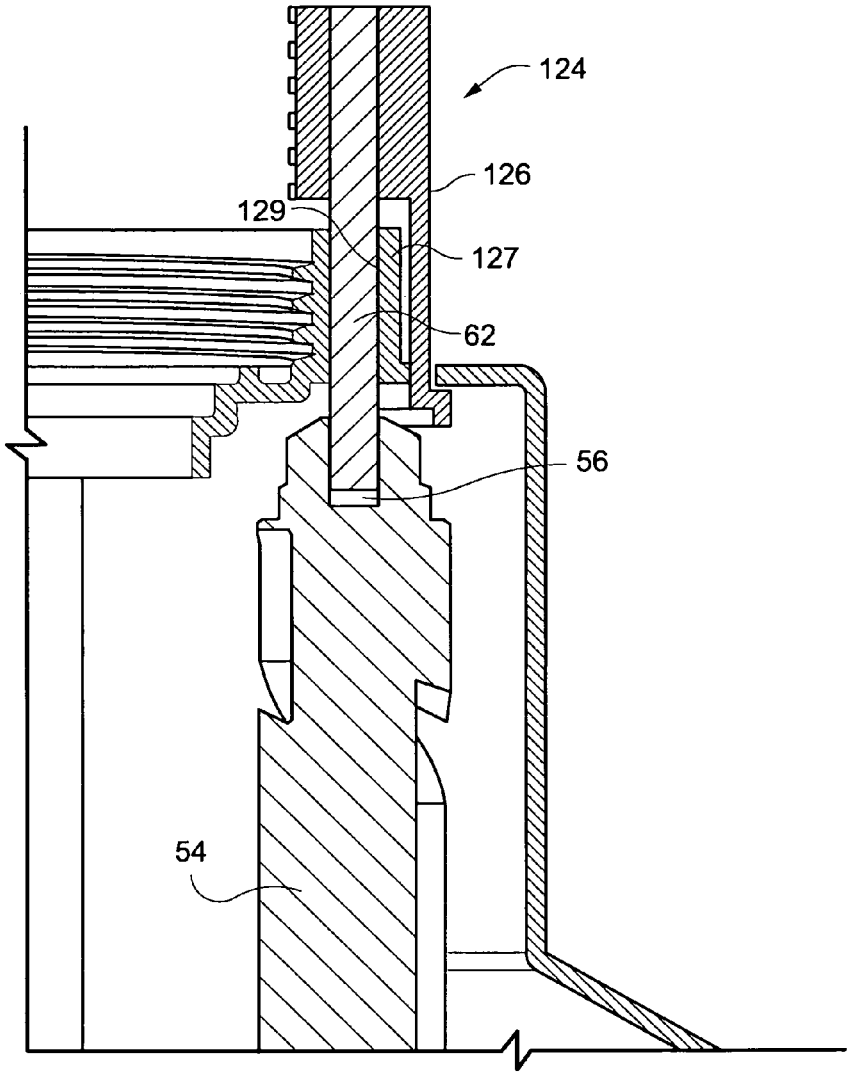


Fig. 34

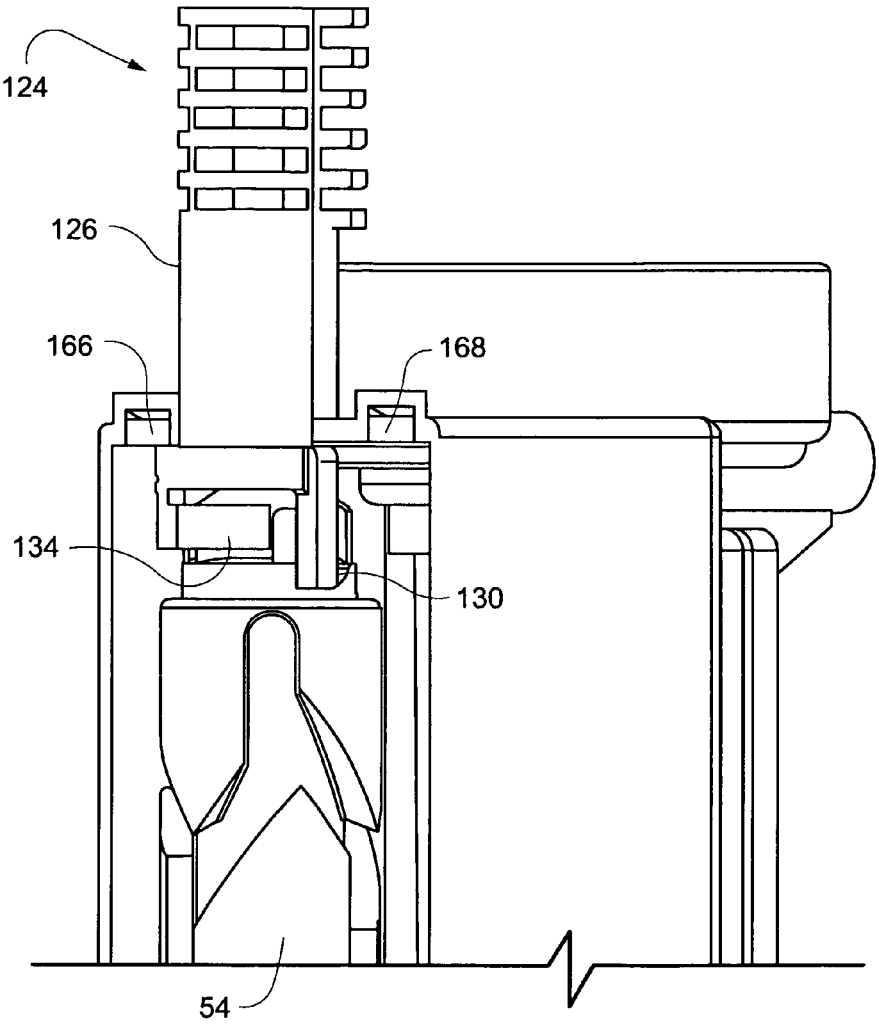


Fig. 35

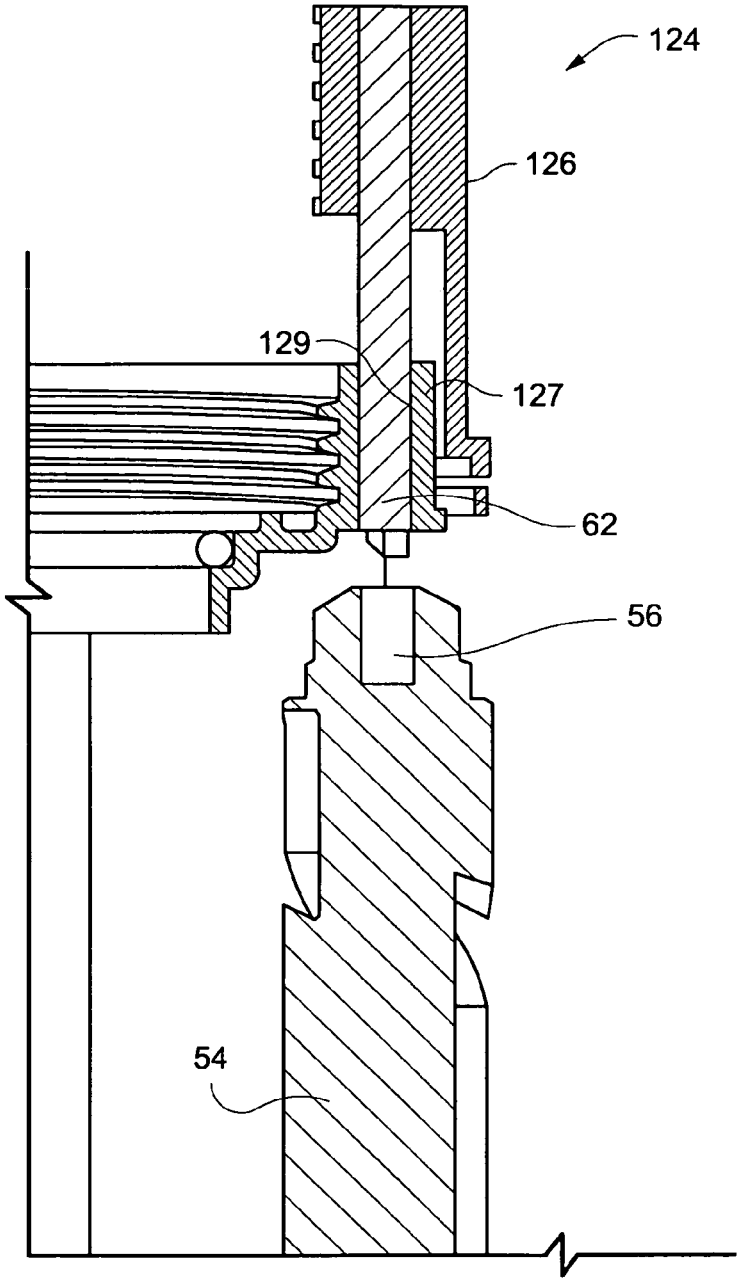


Fig. 36

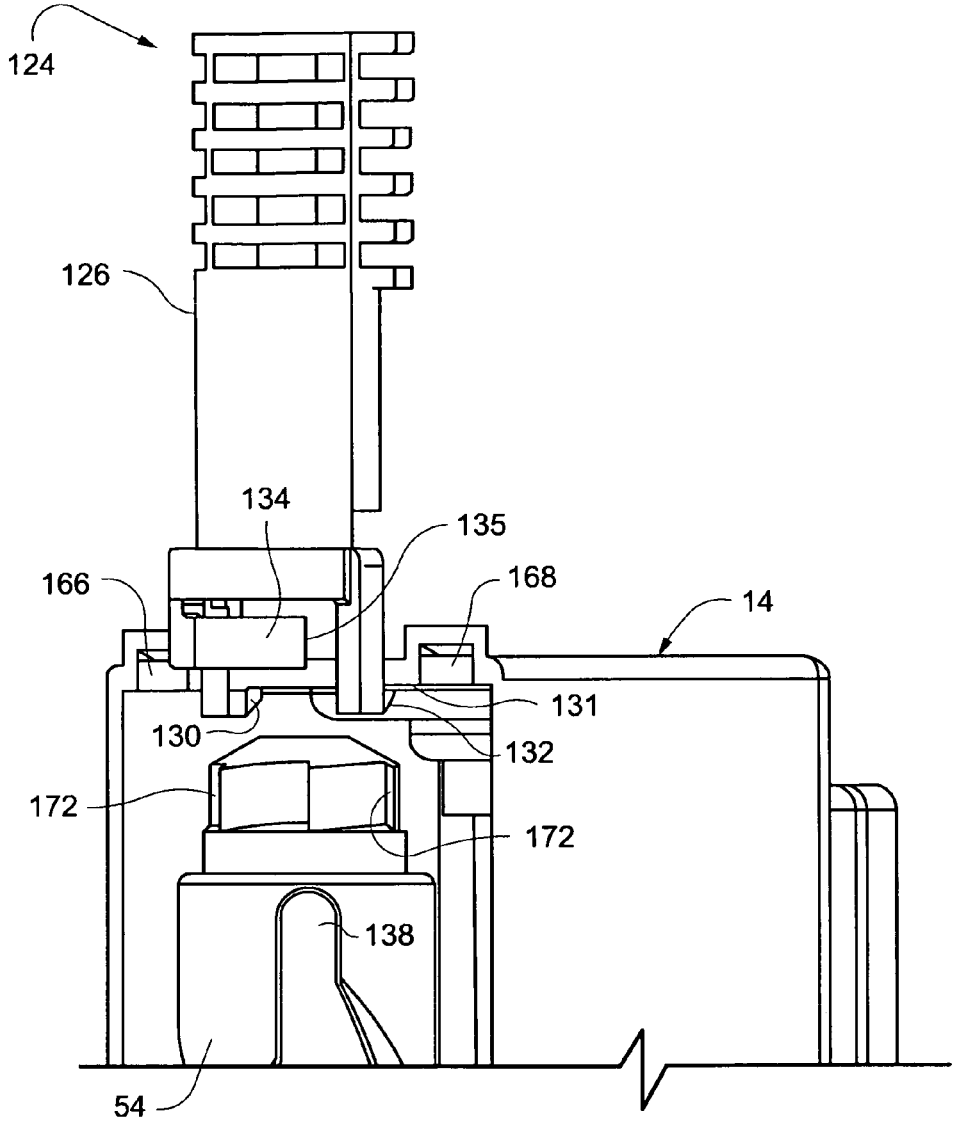


Fig. 37

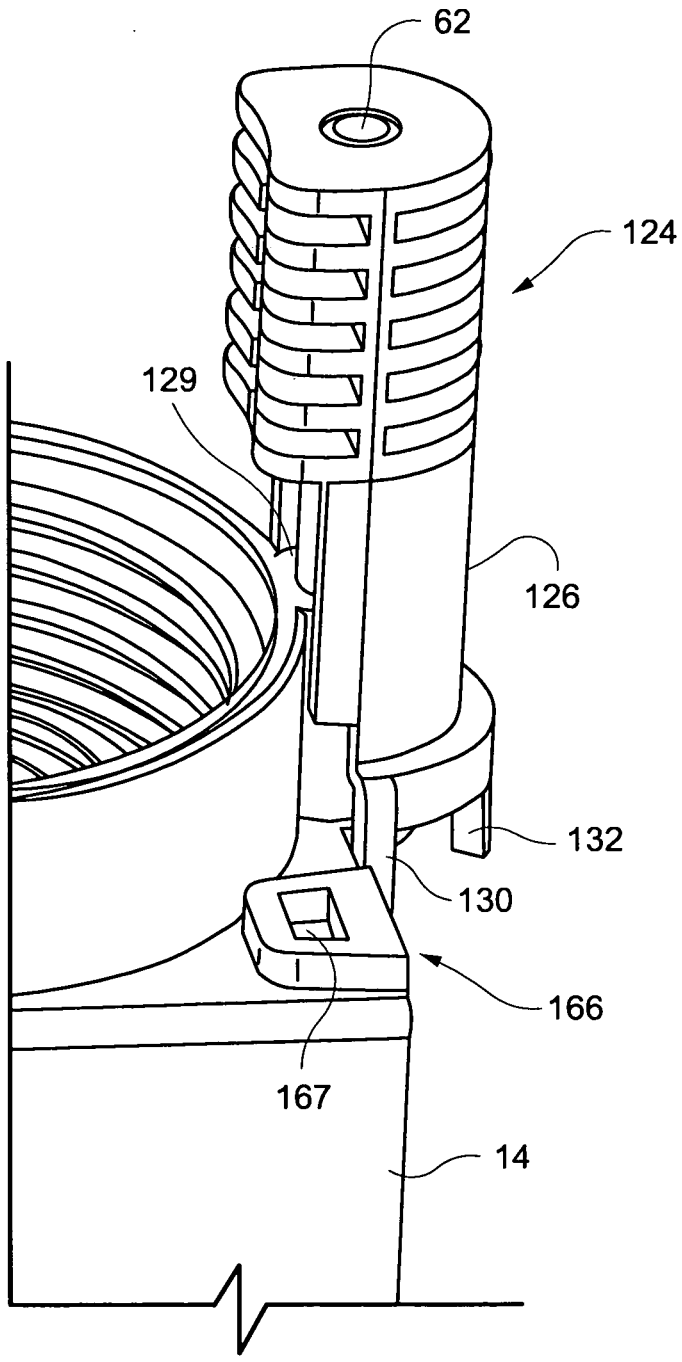


Fig. 38

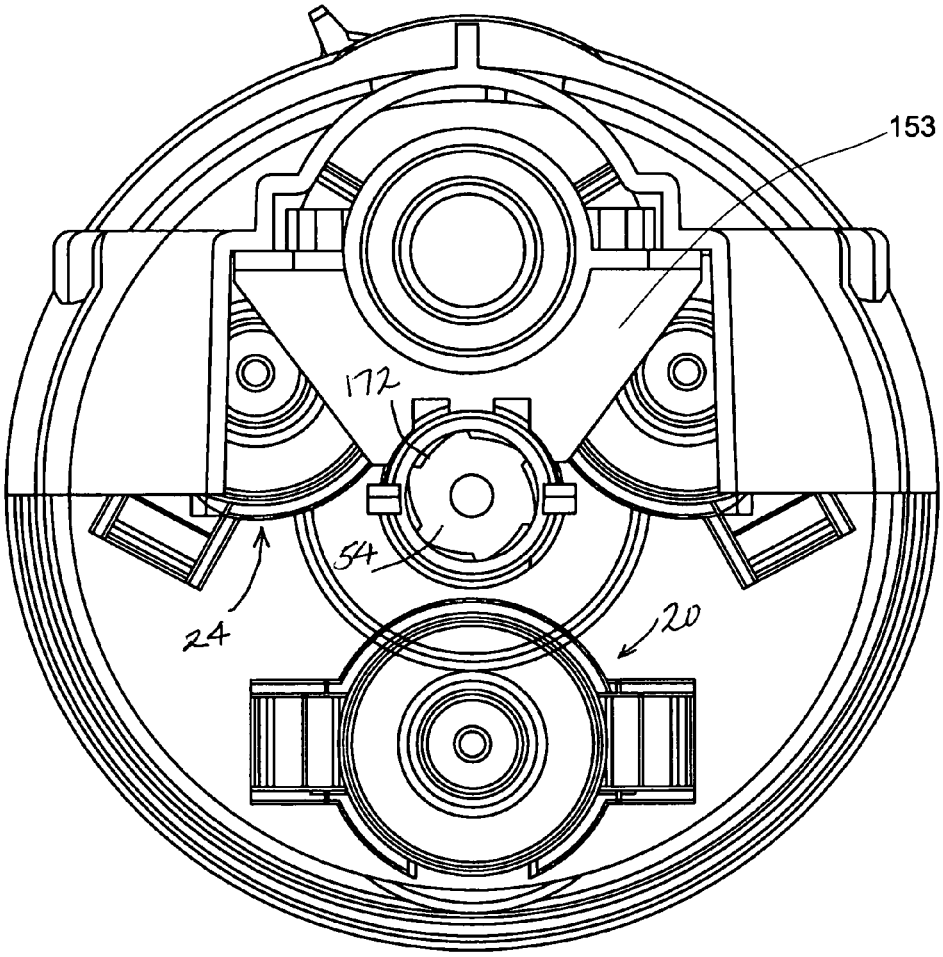


Fig. 39

AUTOMATIC NOZZLE CHANGER

This invention relates to sprinkler devices of the type typically utilized in connection with, but not limited to, conventional pivot-move and lateral-move irrigation systems and more specifically, to a sprinkler device which incorporates an automatic nozzle changer.

BACKGROUND OF THE INVENTION

Mobile irrigation systems such as conventional pivot-move and lateral-move systems typically incorporate truss-span assemblies which mount sprinkler heads spaced along the truss span for irrigating relatively large areas of land. The sprinkler heads may be mounted on top of the truss-span in a normal upright position, or they may be inverted and suspended from the truss-span by means of drop tubes or the like.

Because of the large number of sprinkling heads utilized in a conventional pivot-move or lateral-move irrigation system, and because of the remote locations of such systems, it is important to be able to replace, and/or repair sprinkler heads simply, quickly and efficiently. The assignee currently manufactures modular spray heads which include a sprinkler body adapted to accept interchangeable nozzles and spray plates. In commonly-owned U.S. Pat. No. 5,415,348, for example, a modular sprinkler assembly is disclosed which incorporates an easily identifiable and changeable nozzle sandwiched between the sprinkler body and a hose adapter. Changing the nozzle, however, requires disassembly of the sprinkler. In commonly-owned U.S. Pat. No. 5,762,269, there is disclosed a sprinkler incorporating a nozzle clip that holds a second alternatively useable nozzle laterally adjacent to a first installed nozzle. The clip is manually reversible such that the first and second nozzles are selectively interchangeable.

There remains a need, however, for the sprinkler device that incorporates a number of selectively useable nozzles of varying orifice size, and wherein the nozzles may be changed automatically on site or from remote locations.

BRIEF SUMMARY OF THE INVENTION

In an exemplary but nonlimiting embodiment, the present invention enables an operator to automatically change the flow rate of a single sprinkler or the flow rates of plural sprinklers in a multi-sprinkler irrigation system (uniformly or differentially). This is achieved by incorporating a nozzle magazine carrying a plurality of interchangeable nozzles of different size (i.e., flow rate) which will permit a single sprinkler to have, for example, three alternatively specified flow rates. To this end, a hydraulic or pneumatic actuator is employed with a control system that automatically implements a nozzle-change cycle. An irrigation system incorporating this technology may be used for site-specific irrigation or other applications where, for example, the water flow rate needs to be varied for all sprinklers at specified time intervals, or for individual sprinklers at individually-specified time intervals, along the length of a truss span.

In another example, a circle-pivot irrigation system irrigating a sensitive crop may require light watering for germination, increased watering after the crop emerges, and even more watering as the crop matures. The automatic nozzle changer as described herein has the ability not only to accommodate the various growth stages of the crop, but also saves water by using only the amount of water needed at specific times.

It is another feature of the invention that the nozzle-changer assembly actuators may be controlled by wireless communication using GPS, RFID tags, etc. with a suitably programmed microprocessor on site or at a remote location.

Accordingly, in a first exemplary but nonlimiting embodiment, the invention relates to a sprinkler assembly comprising: a housing having an open side; a sprinkler body supported at one end of the housing and adapted to receive a nozzle; a nozzle magazine attached to the housing along the open side and holding plural nozzles selectively alignable with the sprinkler body; and an actuator for moving a selected one of the plural nozzles from the nozzle magazine into the nozzle body.

In another aspect, the invention relates to a nozzle magazine for use with a sprinkler to enable nozzles of varying size to be interchangeably inserted into the sprinkler, the nozzle magazine comprising: a spindle having upper and lower ends defining an axis of rotation; a nozzle tray adjacent one end of the spindle, the nozzle tray having plural through-holes, each supporting a respective nozzle; and wherein an opposite end of the spindle is formed with a compound cam groove adapted for interaction with an actuator cam, said compound cam groove arranged to rotate the nozzle magazine in a first angular direction upon movement of said actuator cam in a first linear direction, and to rotate the nozzle magazine further in said first angular direction upon movement of said actuator cam in a second linear direction opposite said first linear direction.

In still another aspect, the invention relates to a method of changing a nozzle in a sprinkler head comprising:

(a) providing a rotatable nozzle magazine holding a plurality of nozzles, one of said nozzles located in said sprinkler head;

(b) retracting said one nozzle and, during retraction, rotating said nozzle magazine in a first direction through a first predetermined angle;

(c) advancing another of said nozzles towards said sprinkler head and, while advancing, further rotating said nozzle magazine in said first direction through a second predetermined angle to thereby place said another of said nozzles in axial alignment with said sprinkler head; and

(d) without further rotation of said nozzle magazine, inserting said another of said nozzles into said sprinkler body.

The invention will now be described in greater detail in connection with the drawings identified below:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation of a sprinkler and nozzle changer assembly in accordance with an exemplary but nonlimiting embodiment of the invention;

FIG. **2** is a front elevation view of the assembly shown in FIG. **1**;

FIG. **3** is a cross section through an actuator assembly removed from the device shown in FIGS. **1** and **2**;

FIG. **4** is an enlarged perspective view of a nozzle magazine removed from the assembly shown in FIGS. **1** and **2**;

FIG. **5** is a section through the nozzle magazine shown in FIG. **4** but rotated 180°;

FIG. **6** is a top perspective view of the assembly shown in FIG. **4**;

FIG. **7** is a bottom plan view of the assembly shown in FIG. **4**;

FIG. **8** is a section taken along the line **8-8** in FIG. **6**;

FIG. **9** is a section taken along the line **9-9** in FIG. **2**;

FIG. **10** is a section taken through the assembly shown in FIG. **1**, but rotated 90°;

FIG. **11** is an elevation of the nozzle magazine assembly similar to FIG. **5** but with the actuator head attached in a fully retracted position;

FIG. **12** is a view similar to FIG. **11** but rotated to the right 45° and with only the magazine cam post shown in the cam groove for the sake of clarity;

FIG. **13** is a view similar to FIG. **12** but with the actuator cam post shown at the lower end of the upper axial portion of the cam groove;

FIG. **14** is a view similar to FIG. **13** but with the actuator cam post shown in a further downwardly advanced position within the helical advance portion of the cam groove, and with the nozzle magazine rotated to the right;

FIG. **15** is a view similar to FIG. **14** but with the actuator cam post shown in still further downwardly advanced position at the upper end of the lower axial portion of the cam groove, and with the nozzle magazine rotated further to the right;

FIG. **16** is a section view of the sprinkler and nozzle changer assembly with the actuator cam post and nozzle magazine in a position generally corresponding to that shown in FIG. **15**;

FIG. **17** is a view similar to FIG. **15**, but with the actuator cam post in its fully advanced position at the lower end of the lower axial portion of the cam groove;

FIG. **18** is a section view of the sprinkler and nozzle changer assembly with the actuator cam post in a position corresponding to the actuator position shown in FIG. **17**;

FIG. **19** is a section view similar to FIG. **18** but with the actuator head and nozzle magazine rotated 90° to the right;

FIG. **20** is a section view similar to FIG. **19** but illustrating the nozzle changer actuator assembly in a partially retracted position;

FIG. **21** is a view similar to FIG. **20** but illustrating the actuator in a further retracted position;

FIG. **22** is an elevation of the nozzle magazine generally corresponding to FIG. **21** showing the actuator cam post at the end of its movement in the lower axial retraction portion of the cam groove;

FIG. **23** is an elevation of the nozzle magazine similar to FIG. **22** but with the actuator cam post in a helical retraction portion of the cam groove;

FIG. **24** is a view similar to FIG. **23** but illustrating the actuator cam post in its fully retracted position within the upper axial portion of the cam groove;

FIG. **25** is an enlarged partial side elevation of the cam groove in the spindle portion of the nozzle magazine;

FIG. **26** is a partial side elevation similar to FIG. **25** but rotated 30° to the right;

FIG. **27** is a side elevation view of a nozzle magazine retaining pin assembly;

FIG. **28** is an isometric elevation illustrating the manner in which the nozzle magazine and an outer cover may be attached to the sprinkler and actuator assembly;

FIG. **29** is a side elevation illustrating a further aspect of the nozzle magazine retaining pin assembly;

FIG. **30** is a partial section view showing the connection between the lower end of the nozzle magazine and the housing;

FIG. **31** is a partial section view showing the connection between the upper end of the nozzle magazine and the housing;

FIG. **32** is an elevation view showing the assembly of a cover to the open side of the housing;

FIG. **33** is a partial perspective view showing a guide structure in the nosepiece engaged with the spindle;

FIG. **34** is a section view of the nozzle retaining pin assembly engaged with the spindle.

FIG. **35** is a partial elevation showing the retaining pin assembly in a raised position relative to the nozzle magazine and housing;

FIG. **36** is a partial elevation showing the retaining pin assembly in a lowered position, locking the nozzle magazine to the housing;

FIG. **37** is a partial elevation showing the retaining pin in a retracted position;

FIG. **38** is a partial perspective view of the retaining pin assembly in a retracted position; and

FIG. **39** is a partial top plan view showing how the nozzle insertion tool slides within the sprinkler housing.

DETAILED DESCRIPTION OF THE DRAWINGS

With initial reference to FIGS. **1-4**, sprinkler assembly **10** in accordance with a first exemplary but nonlimiting embodiment includes generally a sprinkler body **12** connected to a hollow elongated housing **14** by means of a threaded connection shown at **16** (FIG. **9**). It will be appreciated that the sprinkler body mounts a conventional water distribution plate (not shown) to the securement ring **13**. The housing **14** has an open side which receives and supports a nozzle magazine **18** (or simply, magazine) adapted to hold a plurality of interchangeable nozzles **20**, **22** and **24** (see FIGS. **4** and **6**) of conventional construction. An actuator assembly (or actuator) **26**, best seen in FIG. **3**, includes a hydraulic or pneumatic cylinder **28** and a hollow piston rod **30** fitted with a piston **32** moveable within the cylinder **28**. The cylinder is ported at its upper and lower ends in conventional fashion, permitting the piston to be driven in either direction. An annular piston ring or seal **34**, located within a groove formed in the piston, seals against the internal surface of the cylinder **28** in conventional fashion. At the upper end of the cylinder **28**, an upper retaining ring **36** holds an annular, upper rod seal **38** in place, while a lower retaining ring **40** and a lower rod seal **42** are arranged to seal the lower end of the cylinder against the housing as shown in FIG. **9**. The upper end of the piston rod **30** is adapted to be connected to a flexible water supply hose or conduit (not shown). In this regard, it will be appreciated that the water under pressure will flow through the piston rod **30** and through the nozzle magazine before reaching the installed nozzle.

At the lower end of the piston rod **30**, a piston rod nosepiece (sometimes referred to as a nozzle insertion tool) **44** is secured to the piston rod **30** by means of a threaded connection at **46**. The nosepiece **44** is effectively a nozzle insertion/removal tool and to this end is provided with an annular pusher surface **47** for effecting insertion of a selected nozzle (**20**, **22** or **24**) into the sprinkler body **12**, and a pair of gripper arms **48** (best seen in FIG. **11**) for retracting the selected nozzle from the sprinkler body **12** in a nozzle-change cycle described further herein. A pair of radially extending tabs **49** engage flat surfaces in the housing **14**, preventing the piston rod **30** and nosepiece **44** from rotating during advance and retraction movements and thus maintaining correct positioning of the cam post **136** relative to the compound cam groove **140**. (See, for example, FIGS. **10**, **19**, **20**, **21** and **39**.) An annular face seal **50** is provided at the lower end of the nosepiece **44** for sealing against a flange **90** of a nozzle-holding sleeve **88** (see FIG. **16**) as described further herein.

The hollow piston rod **30** and the nosepiece **44** are moveable in up and down directions relative to the fixed cylinder **28**, housing **14** and sprinkler body **12**. In this regard, the cylinder **28** is secured to the housing **14** by means of a

threaded connection shown at **52**. (See FIG. **19**.) As will be explained further herein, the actuator **26** and nosepiece **44** are used to insert a nozzle (**20**, **22** or **24**) held in the magazine **18** into the sprinkler body **12**, and to remove that nozzle and replace it with another nozzle (also held in the magazine) when desired. In this regard, the magazine **18** is able to rotate or index to a position where a selected one of the nozzles **20**, **22** or **24** is axially aligned with the piston rod **30** and nosepiece **44**.

With reference especially to FIGS. **4-8** and **16**, the magazine **18** is formed with a center spindle **54** which, when assembled, extends parallel and adjacent to the actuator piston rod **30**. The spindle **54** is provided with upper and lower recesses **56**, **58** which together define an axis of rotation for the magazine **18**. The upper and lower recesses **56**, **58** are engaged by a retaining pin **62** and a boss **64**, respectively. (See also FIG. **30**.)

The magazine **18** is also formed with a round tray body **66** adjacent the lower end of the spindle **54**. The tray body **66** has an upper surface **68** and a lower surface **70**. In the exemplary embodiment, the tray body is formed with three axially-oriented, equally-spaced openings **72** that extend through the tray body. Each opening **72** is generally cylindrical in shape, and is defined in part by an upper wall **74** substantially surrounding the respective opening and comprised of a pair of generally arcuate, diametrically-opposed wall portions **76**, **78**, as best seen in FIGS. **5** and **6**. Centrally located within the respective arcuate wall portions **76**, **78** are radially inwardly facing, tapered cam slots **80**, **82**, respectively, extending into the openings **72**. In addition, each opening **72** is formed with a counter-bored portion **84** and a lower exit flange **86** (FIG. **5**). The tapered and stepped contour of the slots **80**, **82** controls the movement of the gripper arms **48** to the extent of providing the timing for clamp and release functions relative to the nozzle holding sleeves **88** described below.

A cylindrical nozzle-holding sleeve **88** is slidably received within each of the three openings **72** as best seen in FIG. **5**. Each nozzle-holding sleeve **88** is formed with a radially outwardly extending flange **90** at its upper end that, in a nozzle retraction position, lies substantially flush with the upper edge of the wall **74**; and a pair of diametrically-opposed, reverse-bend spring tabs **92**, **94** (FIG. **5**) at its lower end, adapted to hold a respective one of the nozzles. Because the nozzles **20**, **22** and **24** and their respective nozzle-holding sleeves **88** are identical, only one of each need be described in detail. Nozzle **20**, for example, includes a nozzle body **96** formed with an internal tapered surface **98** extending between an inlet **100** and an outlet orifice **102**. A lower annular ring portion of the nozzle body includes a radial flange **104** that supports a plurality (four in the example embodiment) of equally-spaced upwardly-extending spokes or struts **106** that terminate at an angled identification ring or flange **108**. The flange **108** may include nozzle size data or the like visible to the user. The spokes or struts **106** define a plurality of circumferentially-spaced openings **110**. When the nozzle **20** is inserted within the counter-bored portion **84** at the lower end of the nozzle-holding sleeve **88** (best seen in FIGS. **5** and **8**), the lower spring tabs **92**, **94** are initially compressed as the nozzle moves into the sleeve. The spring tabs expand radially outwardly as they are received within a respective pair of the openings **110**. The nozzle **20** is thus retained on the nozzle sleeve **88** and remains so attached for all nozzle-change operations described further herein. It will be understood, however, that individual nozzles may be easily replaced within the respective nozzle sleeves as desired. An O-ring seal **112** seals the bottom edge of the sleeve **88** to the nozzle.

For each cylindrical nozzle sleeve **88**, there is a coil spring (or other equivalent) **114** engaged between the underside of the upper annular flange **90** and the inside surface of the lower flange **86** of the respective opening **72** (shown only in FIGS. **5** and **8**) that normally maintains a nozzle sleeve **88** in the neutral position shown in FIGS. **5** and **8** when that nozzle is not in use. For an installed nozzle, the spring **114** insures that the nozzle-holding sleeve will be pushed upwardly during retraction sufficiently to allow the magazine to rotate as described in greater detail below.

On the underside of the nozzle magazine **18**, there are arranged three reinforcing or support webs **116**, **118** and **120** extending between the lower surface **70** and the lower boss **122** which defines the lower recess **58**. This aspect of the construction is exemplary only, and may be varied as desired for ease of manufacture, etc.

A nozzle magazine retaining pin assembly **124** (FIGS. **2**, **9**, **16**, **18**, **27**, **29**, **31**, **32** and **34-38**) is utilized to lock the magazine **18** in place within the sprinkler housing **12** as best seen in FIG. **9**. The nozzle magazine retaining pin assembly **124** includes an elongated retaining pin body **126** that supports the cylindrical lock or retaining pin **62** and a pair of stops **130**, **132** at the lower end of the pin body **126**. The lock or retaining pin **62** is pressed into a bore **133** in the retaining pin body **126** and remains stationary relative to that body. As shown in FIG. **34**, the retaining pin **62** projects below the pin body **126**, permitting the pin **62** to also extend through a bore **127** provided in a boss **129** formed on the housing **14**, thus permitting the retaining pin assembly **124** to move up and down relative to the housing **14**. The retaining pin **62** also projects below the boss **129** so that the pin may be inserted into and removed from the recess **56** at the top of the spindle **54**. The stops **130**, **132** engage under an edge **131** of the housing **14** to prevent removal of the retaining pin assembly **124** when the latter is in a retracted position. (See FIG. **37**.) A horizontally-oriented tab **134** with a free edge **135** is formed adjacent the stops, the purpose for which will also be explained further herein.

Turning to FIG. **28**, after the magazine **18** is loaded with nozzles **20**, **22** and **24** by locating the latter in the lower ends of the respective sleeves **88** as described above, the magazine **18** is attached to the housing **14** by first locating the lower boss **64** in the lower recess **58**. The magazine is then tilted upwardly to a substantially vertical position, enabling the retaining pin assembly **124** to be pushed downwardly such that the retaining pin **62** is engaged within the upper recess **56** in the spindle **54**. (See, for example, FIGS. **16**, **18** and **34-38**.) As the magazine is pivoted upwardly, a guide plate **153** (FIG. **33**) attached to the nosepiece **44** assists in the alignment of the spindle **54** by means of a multi-pronged recess **155**. Once the nozzle magazine **18** is assembled in place within the housing **14**, a removable outer cover **156**, which covers the exposed nozzles (i.e., the nozzles not aligned with the actuator piston rod **30**), is snapped into place (FIGS. **28**, **29**, **32**). More specifically, the cover **156** may be made of a suitable transparent plastic material which enables the user to view the nozzles held in the magazine, and at the same time, prevents debris from entering the area where the actuator and nozzle magazine interface. The cover **156** spans approximately 180 degrees and attaches to the open side of the housing **14** at its lower end by means of a pair of tabs **157** (one shown in FIG. **32**) receivable within a pair of recesses **158**, **160**, respectively, formed in the housing **14** (see FIG. **29**). Because tabs **157** engaged in the recesses **158**, **160** have down-turned edges, the cover **156** may pivot upwardly about its lower end so as to engage the housing **14** at its upper end. Specifically, tabs **162**, **164** (FIG. **32**) snap into open-ended bosses **166**, **168** (FIGS.

32, 35-38). Note that the tabs **162**, **164** have enlarged, rounded ends so that they will snap into the recesses, with the enlarged, rounded ends moving into openings **167** formed at the top of the respective bosses, best seen in FIG. **38**. At the same time, a horizontal, arcuate surface **169** at the top of the cover **156** (FIG. **32**) will seat on an arcuate shoulder **170** on the retaining pin body **126**.

Returning to FIG. **9**, when the nozzle magazine **18** is located such that the boss **64** is received in recess **58** and the retaining pin **62** is received in the upper recess **56**, the magazine **18** is rotatable to locate any one of the interchangeable nozzles **20**, **22** and **24** into a position where the longitudinal axis of the selected nozzle and respective nozzle-holding sleeve **88** are coaxial with the longitudinal axis of the actuator piston rod **30**.

In the assembled configuration, a horizontally oriented nub or cam post **136** on the nosepiece **44** engages one of three axially-oriented upper axial groove portions **138** of an otherwise compound cam slot or groove **140** formed in the spindle **54**. The three upper groove portions **138** are arranged at 60-degree intervals about the spindle. Each upper axial groove portion **138** communicates (or opens into) a pair of helically-configured groove portions **142** (advance) and **144** (retract). The advance groove portion **142** and retraction groove portion **144** meet at an upper apex **146** that is laterally offset from the longitudinal axis of the upper axial groove portion **138**. At the same time, the adjacent groove portions **144**, **142** meet at a lower apex **148** that is axially offset from a lower axial groove portion **150**. The movement of the cam post **136** within the compound cam groove **140** during a complete nozzle-change cycle will be described further below.

Operation

With reference now to FIGS. **9-12**, the actuator piston rod **30** is shown in its fully-retracted position, with the nosepiece **44** spaced axially above the nozzle-supporting sleeves **88** in the magazine tray body **66**. In this position, the gripper arms **48** of the nosepiece **44** are in a normally outwardly-sprung position and the horizontal cam post **136** is located within one of the upper axial groove portions **138**. This arrangement is likely only to be observed before initial use when a selected nozzle is to be inserted into the sprinkler body **12**. As best seen in FIGS. **13** and **14**, as the piston rod **30** begins to advance in a downward direction, the horizontal cam post **136** will travel along the upper axial groove portion **138**, catch the upper apex **146** and move into the helical advance groove portion **142** initiating a 60-degree rotational movement of the nozzle magazine **18** about its rotational axis. Thus, as the hollow piston rod **30** advances, the cam post **136** is exerting a downward force on the helical advance groove portion **142** causing rotation of the magazine **18**. When the cam post **136** reaches the lower axial groove portion **150** (see FIG. **15**), the rotational indexing portion of the advance cycle is complete, and the magazine **18** is locked in position as the hollow piston rod **30** continues to advance, causing the pusher surface **47** on the nosepiece **44** to push the nozzle sleeve **88** and hence nozzle **24** downwardly into the sprinkler body **12** as best seen in FIGS. **16-19**. During this final axially-downward movement, the gripper arms **48** are cammed inwardly by a first tapered surface **83** in each of the opposed slots **80**, **82**, the camming movement timed to have the arms **48** compress inwardly and slide under the flange **90** on the sleeve **88** (see FIG. **19**) when the cam post **136** is travelling in the lower axial groove portion **150**. During this final downward movement of the piston rod **30** and nosepiece **44** to the fully extended position, the arms **48** slide along the straight, non-tapered portions **85** of the slots **80**, **82**. It will thus be appreciated that in the normal operating position, the piston rod **30** and nosepiece **44** are fully extended and hold the selected nozzle **24** in place within the sprinkler body **12**, with water under pressure flowing through the hollow piston rod **30**, sleeve **88** and nozzle **24**.

When it is desired to change the flow rate of the installed nozzle **24**, a nozzle-change cycle is commenced by a command to the actuator **26** to drive the hollow piston **30** in an upward or retraction direction (from the position shown in FIGS. **17** and **19**). Upon initial upward, axial movement, with the cam post **136** travelling in the lower axial groove portion **150**, the gripper arms **48**, located underneath the upper annular flange **90** on the nozzle sleeve **88**, will pull the sleeve and nozzle **24** upwardly out of, and away from, the sprinkler body **12**. During further axial retraction movement (as the cam post **136** continues to ride in the lower axial groove portion **150**), the gripper arms **48** (as well as pusher surface **47**) will release from the sleeve flange **90** as they slide up the tapered surfaces **83** of the slots **80**, **82**. (See FIGS. **20**, **21**.) Further upward movement of the sleeve **88** and its attached nozzle is effected by the coil spring **114**. Thus spring **114** insures that the sleeve **88** and nozzle **24** are raised sufficiently upwardly to permit rotation of the magazine **18** without interference. As the piston rod **30** continues to move upwardly, the cam post **136** will catch on the lower apex **148** (FIGS. **22**, **23**) and move into the helical retraction groove portion **144** causing a 60-degree rotation of the nozzle magazine **18** to the right (in the clockwise direction as viewed from below), rotating the retracted nozzle **24** away from the piston rod **30** while continuing to move upwardly. At the same time, the next adjacent nozzle **22** (and its respective sleeve **88**) rotates toward the piston rod **30** and nosepiece **44**. Following the 60-degree rotation caused by the retraction groove portion **144**, the cam post **136** will reenter the next adjacent upper axial groove portion **138**, completing the upward retraction movement. (See FIG. **24**.)

Thereafter, movement of the actuator piston **30** is again reversed via further command to the actuator **26**, and the piston rod **30** is driven downwardly to complete the rotation of the adjacent nozzle **22** into axial alignment with the piston rod **30** and nosepiece **44**, and thereafter insert the newly selected nozzle **22** into the sprinkler body **12** in the same manner as described above in connection with the initial insertion of the nozzle **24** into the sprinkler body **12**. It will thus be appreciated that a full nozzle-change cycle (retraction and advance movements) includes a 120-degree rotation of the nozzle magazine **18**, including one 60-degree rotation of the magazine **18** on retraction of the installed nozzle, and a second 60-degree rotation on advancement and installation of the replacement nozzle.

Any further nozzle-change cycle to replace the second nozzle **22** with the third nozzle **20** occurs in the same manner, noting that each cycle starts with the cam post **136** in one of the three lower axial groove portions **150**, and that identical helical retraction, helical advance and upper axial groove portions **138** are provided for each lower axial groove portion **150**. In addition, it will be understood that one of the nozzles could be a "dummy" nozzle which has no orifice, thereby making it possible to shut off the flow of water through a particular sprinkler in accordance with a designed sprinkling regimen.

To further control the indexing rotation of the magazine **18**, the uppermost portion of the spindle **54** is formed with six axially-extending position slots **172** spaced at 60-degree intervals about the spindle **54**. (See FIG. **33**.) The position slots correspond to the incremental 60-degree rotations of the magazine **18**, such that the edge **135** of the horizontal, arcuate tab **134** on the retaining pin body **126** will engage an edge of a position slot **172** at the completion of each 60-degree rota-

tion of the magazine. (See FIG. **36**.) The position slots insure that the cam post **136** on the nosepiece **44** will properly engage the helical portions of the compound cam groove **140** on the spindle **54** as it transitions from the axial groove portions to the helical groove portions each time the actuator advances or retracts. In this regard, the position slots **172** also prevent the spindle from rotating backward in an opposite direction.

As will be appreciated by those skilled in the art, the above-described cycle may be implemented automatically at the same or varied time intervals by a suitable programmed microprocessor via GPS, radio signals (infrared or RFID), etc. either at the site or at a remote site.

It will also be appreciated that various aspects of the nozzle changer may be varied but remain within the scope of the invention. For example, the manner in which the magazine **18** is attached to the housing **14** and actuator **26**, and the manner in which the cover **156** is attached to the housing may be modified, using any suitable mechanical attachment mechanisms. Similarly, the retaining pin assembly **124** as described is merely exemplary of various moveable locking pin arrangements that might be employed. The choice of actuator and related seals is also within the skill of the art.

Accordingly, while the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

I claim:

1. A sprinkler assembly comprising:

a housing having an open side;

a sprinkler body supported at one end of said housing and adapted to receive a nozzle;

a nozzle magazine attached to said housing along said open side and holding plural nozzles selectively alignable with said sprinkler body; and

an actuator for rotating the magazine to align a selected nozzle with a flow path through the sprinkler body and for moving the selected one of said plural nozzles relative to said nozzle magazine and linearly into said sprinkler body.

2. The sprinkler assembly of claim **1** wherein said actuator comprises a hydraulic or pneumatic cylinder attached to an opposite end of said housing.

3. The sprinkler assembly of claim **2** wherein a hollow piston rod moves within said cylinder, a free end of said hollow piston rod mounting a nozzle insertion tool.

4. The sprinkler assembly of claim **2** wherein said nozzle magazine includes a tray formed with plural openings, each opening receiving a substantially cylindrical nozzle sleeve, each of said plural nozzles supported in a respective nozzle sleeve.

5. The sprinkler assembly of claim **3** wherein said nozzle insertion tool comprises a pusher surface adapted to insert a selected one of said plural nozzles into said sprinkler body, and a pair of gripper arms adapted to remove another of said plural nozzles from said sprinkler body.

6. The sprinkler assembly of claim **5** wherein said pusher surface engages an upper end of said respective nozzle sleeve, and wherein said gripper arms are adapted to engage an underside of a radial flange formed at the upper end of said nozzle sleeve, each of said plural nozzles remaining in a respective nozzle sleeve upon insertion into said sprinkler body.

7. The sprinkler assembly of claim **1** wherein said plural nozzles comprise three nozzles, each having a different flow rate.

8. The sprinkler assembly of claim **4** wherein said nozzle magazine includes a spindle, said tray located adjacent one end of said spindle; wherein upper and lower ends of said spindle define an axis of rotation for said nozzle magazine relative to said housing.

9. The sprinkler assembly of claim **8** wherein an opposite end of the spindle is formed with a compound cam groove adapted for interaction with an actuator cam, said compound cam groove arranged to rotate the nozzle magazine in a first angular direction upon movement of said actuator cam in a first linear direction, and to rotate the nozzle magazine further in said first angular direction upon movement of said actuator cam in a second linear direction opposite said first linear direction.

10. The sprinkler assembly of claim **9** wherein said actuator cam comprises a horizontally-oriented cam post fixed to a nozzle insertion tool.

11. The sprinkler assembly of claim **3** wherein one end of said hollow piston rod is in fluid communication with said nozzle and an opposite end of said hollow piston rod is adapted to connect to a water supply conduit at an opposite end thereof, said hollow piston rod thus providing the flow path through the sprinkler body .

12. A sprinkler assembly comprising:

a housing having an open side;

a sprinkler body supported at one end of said housing and adapted to receive a nozzle;

a nozzle magazine attached to said housing along said open side and holding plural nozzles selectively alignable with said sprinkler body, said nozzle magazine further including a spindle, upper and lower ends of said spindle defining an axis of rotation for said nozzle magazine relative to said housing; and

an actuator comprising a hydraulic or pneumatic cylinder for rotating the magazine about said axis of rotation to align a selected one of said plural nozzles with a flow path through the sprinkler body and for moving the selected one of said plural nozzles relative to said nozzle magazine and linearly into said sprinkler body.

13. The sprinkler assembly of claim **12** wherein an opposite end of the spindle is formed with a compound cam groove adapted for interaction with an actuator cam, said compound cam groove arranged to rotate the nozzle magazine in a first angular direction upon movement of said actuator cam in a first linear direction, and to rotate the nozzle magazine further in said first angular direction upon movement of said actuator cam in a second linear direction opposite said first linear direction.

14. The sprinkler assembly of claim **13** wherein a hollow piston rod moves within said cylinder, a free end of said hollow piston rod mounting a nozzle insertion tool comprising a pusher surface adapted to insert a selected one of said plural nozzles into said sprinkler body, and a pair of gripper arms adapted to remove another of said plural nozzles from said sprinkler body.

15. The sprinkler assembly of claim **14** wherein said actuator cam comprises a horizontally-oriented cam post fixed to said nozzle insertion tool.

16. The sprinkler assembly of claim **15** wherein one end of said hollow piston rod is in fluid communication with said nozzle and an opposite end of said hollow piston rod is adapted to connect to a water supply conduit at an opposite end thereof, said hollow piston rod thus providing the flow path through the sprinkler body.

17. A sprinkler assembly comprising:

a housing having an open side;

a sprinkler body supported at one end of said housing and adapted to receive a nozzle;

a nozzle magazine attached to said housing along said open side and holding plural nozzles selectively alignable with said sprinkler body, said nozzle magazine including a tray formed with plural openings, each opening receiving a substantially cylindrical nozzle sleeve, each of said plural nozzles supported in a respective nozzle sleeve;

an actuator for moving a selected one of said plural nozzles from said nozzle magazine into said sprinkler body, said actuator compromising a hydraulic or pneumatic cylinder attached to an opposite end of said housing; and wherein a hollow piston rod moves within said cylinder, a free end of said hollow piston rod mounting a nozzle insertion tool comprising a pusher surface adapted to insert a selected one of said plural nozzles into said sprinkler body, and a pair of gripper arms adapted to remove another of said plural nozzles from said sprinkler body, and further wherein each opening in said tray is formed with diametrically-opposed cam slots adapted to engage and compress said gripper arms about said sleeve.

* * * * *